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ABSTRACT

Part 3 of a three-part volume for research and development systems researchers, this report shows how the contextual analytical approach presented in Part 1 may be used to analyze specific research, development, and innovation (RD & I) issues. Chapter 8 (the first chapter of this part) focuses on the institutional bases of RD & I systems with particular attention being given to how the RD & I functions (presented and explained in Part 1) are clustered together within and among the institutions of RD & I systems. Chapter 9 focuses on the issue of entrepreneurship as it relates to the historical and current state of development of RD & I systems. Chapter 10 discusses issues relevant to implementation and utilization, including the structural attributes of user organizations. Chapter 11 illustrates the use of the contextual analysis framework for policy analysis. Brief summaries are given of policy analyses provided to the National Institute of Education. Chapter 12 reviews the contextual analysis framework. (Author/JM)

RESEARCH, DEVELOPMENT AND INNOVATION:

CONTEXTUAL ANALYSIS

December 1977

Part Three

Michael Radnor
Harriet Spivak
Dunward Hofler

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CHAPTER EIGHT

INSTITUTIONAL BASE: THE NETWORK OF INSTITUTIONS

I: OVERVIEW OF THE INSTITUTIONAL BASE FEATURE

A discussion of R/D&I institutions (i.e., the organizations in which the various stages of the R/D&I process occur) could encompass the totality of issues with which a researcher or policy maker might be concerned. In our case, however, we use the totality of features in a contextual analysis to provide such comprehensiveness. Thus, the institutional base feature focuses in on R/D&I system structure and process (i.e., the network of institutions). Why is it, for example, that R/D&I systems exhibit differences in their structures, the type and roles of the institutions involved in the system network, and the character of the relationships between the constituent institutions? To be more specific, why do we observe in some contexts a very extensive division of activities with considerable specialization of roles and in others we observe a much higher level of role integration within multi-purpose institutions? In some cases the institutions in the system seem to be linked together in a neat set of linear relationships, with each institution being responsible for a well-defined set of steps within the R/D&I process and with these then handing programs on to the next stage. In others we see loops, recycling, institutions that combine idea generation and implementation yet not development, and so on. Why is cooperation between institutions common in one context but rare in others? It is to such institutional network issues that this section is devoted.

There are five main issue areas which must be analyzed in order to gain a comprehensive understanding of the institutional base feature:

R/D&I System Institutions:

1. What are the role functions of the various institutions within the R/D&I system?

2. What are the characteristics of these institutions?

R/D&I System Structures:

3. How are the R/D&I functions structurally configured (clustered) within the R/D&I system?

4. What are the inter-institutional linkages within the R/D&I system?

5. What are the characteristics of structure of the R/D&I system?

Additionally, of course, we will want to identify which institutions form the institutional base of the R/D&I system. Figure 1 summarizes and expands these five main areas.

In analyzing the role functions of the institutions within the R/D&I system, the objective is not to detail the tasks performed in each of the R/D&I functions (e.g.: the development function). This is done in analysis of other features. Rather, the objective is to deal with such questions as: In which institutions do we (or should we) find development work going on? Is it in the knowledge producing, distributing or user organizations, or in some combination of these (and whether in a differentiated or duplicative and redundant manner)? To what extent do we find institutions specializing in one or more of the R/D&I system functions (for example, see Figure 2). We would also wish to know which institutions are part of what we could call the R/D&I superordinate system (providing system resources and constraints and accepting system outputs), the R/D&I coordinate system (part of or parallel to the R/D&I system), or subordinate systems (institutions providing support

Figure 1

Institutional Base
(Network of Institutions)

- Institutions
  - Institutional roles within the R/D&I system
    - Specialization of institutions
      - Research/engineering/development/production, etc.
    - Role in superordinate/coordinate/subordinate systems
    - Sector spanning institutions
  - Institutional characteristics
    - Internal structure
      - Configuration
      - Integration
      - Centralization
      - Formalization
      - Articulation/visibility
      - Stability
    - Internal processes
      - Decision making
      - Communications
      - Authority/status
      - Cooperation
    - Dimensions
      - Size
      - Status
      - Level of maturation

System Structure

- System configuration (clustering) of R/D&I functions
  - Linearity
  - Parallelism
  - Looping/contiguousness
  - Continuity/gaps
  - Redundancy

Inter-institutional linkages

- Linkage characteristics
  - Strength
  - Permanance
  - Formality
  - Directness/mediatedness
  - Visibility
- Interface structure/liaison mechanisms
  - Boundary conditions
    - Open/closed
    - Fixed/variable
- Linkage consequences
  - Functional/dysfunctional
  - Cooperation/conflict
  - Joint ventures
- Characteristics
  - Centralization
  - Formalization
  - Diffuseness
  - Stability
  - Visibility
  - Appropriateness
  - Balance

services); whether institutions perform multi-systems level roles (e.g.: providing both resources and support services); whether institutions are sector-spanning (providing services to several fields -- e.g.: education and health); whether in a given context the institutions are specialist or generalist (with respect to R/D&I functions).

In analyzing the characteristics of the institutions within the R/D&I system, we would want to know about their internal structures (type of configuration, degree of centralization and formalization, etc.); about their internal processes (decision making, communications, authority, status, etc.); about various dimensions such as size, level of maturation or development, etc.

In the process of analyzing the structure of the R/D&I system, we will want to know whether the structural configuration of R/D&I functions is characterized by linearity, parallelism, looping, clusterings of R/D&I functions (which functions?), redundancy, etc.

In the process of examining the structure of the R/D&I system, we will also want to understand how the institutions are linked together. We would want to know which institutions are linked to which other institutions. We would be concerned with whether the links were srong or weak, permanent or temporary, formal or informal, direct or mediated, cooperative or conflictive. The nature and quality of these linkages and interfaces, and the boundaries across which they occur are of central importance.

In analyzing the characteristics of the R/D&I system's structure, we will be asking such questions as: Is the system's structure centralized or decentralized? To what extent is the system's structure formalized? Is the system's structure well articulated and stable throughout the system or is it diffuse and changing?

In Figure 8, we provide two illustrative examples of how an R/D&I system might be concretely structured. As these examples indicate, we do not assume either that all R/D&I systems will be structured similarly or that all R/D&I systems are "complete".

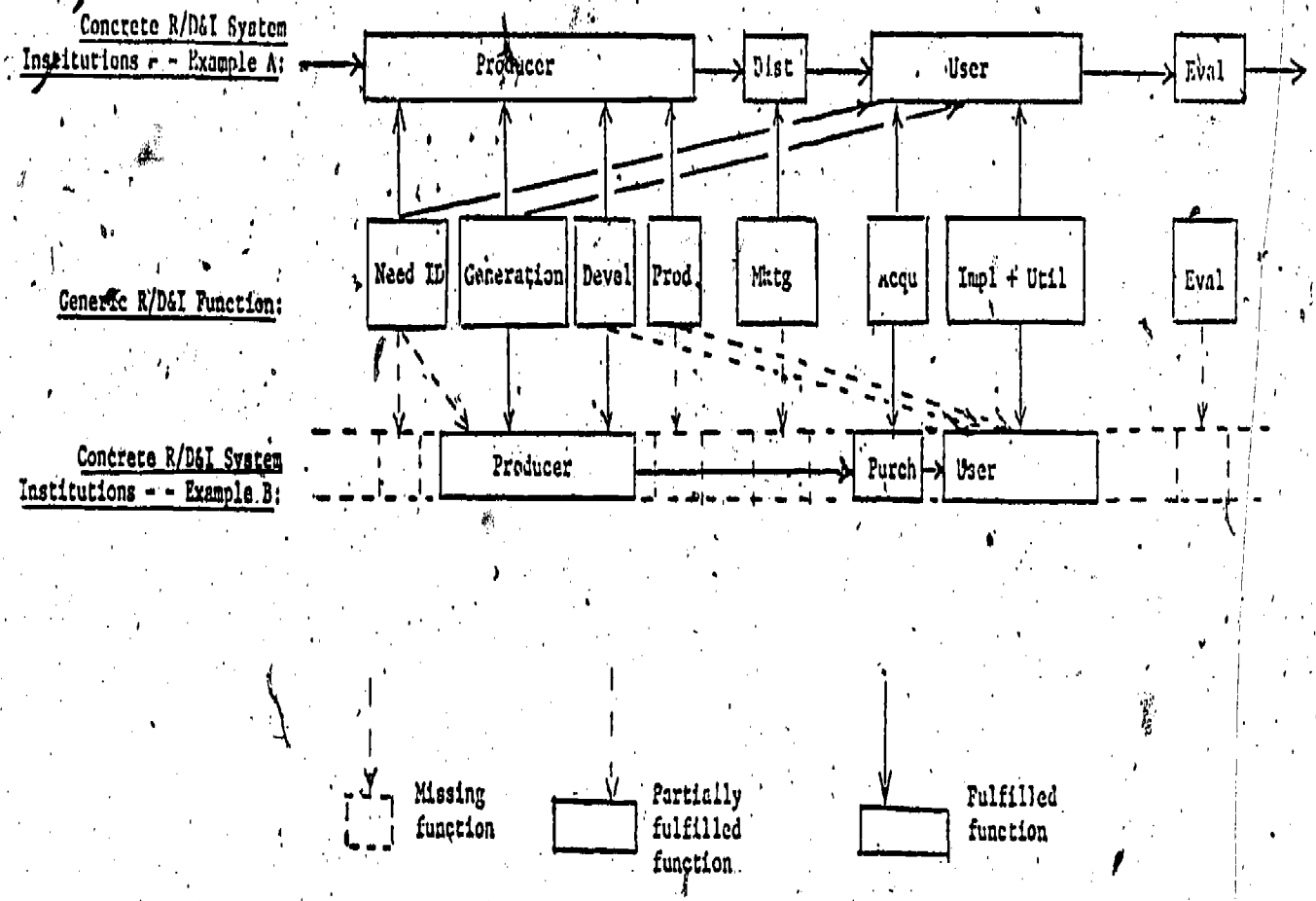


Figure 2

Examples of Intra-System Structures

In example A, we find an integrated producer performing all the generic functions from need identification through production. Marketing is handled by distributors (jobbers). Purchasing, implementation and utilization as well as participating in need identification and generation are user institution functions; and evaluation is carried out by an independent organization (e.g.: federal government). This might describe some aspects of the hospital equipment field.

In example B, producers have only weak linkage to user needs and work only up to the development stage. Prototypes are purchased by an organization that is separate from the users. This happens, for example, when city governments centrally purchase for their operating units (e.g.: police or fire departments). Evaluation may be virtually non-existent. In fact, this process describes our findings in a recent study of the innovation process in law enforcement equipment - - with special reference to voice identification equipment.(2)

We now turn to more detailed illustrations of how our contextual analytical framework can be utilized in relation to various feature issues. To do this, we have narrowed the focus of our analysis by selecting sub-issues from among the list of issues in Figure 1.

II: DETAILED SUB-ISSUE ANALYSIS: R/D&I SYSTEM STRUCTURE AND INSTITUTIONAL ROLES IN THE R/D&I SYSTEM

1. Narrowing the Focus of Analysis: Specialization and Configuration

In this detailed sub-issue analysis, we have chosen to focus on the R/D&I functions. To sharpen this focus further, we have selected two sub-issues: specialization of institutions (with respect to the R/D&I functions) in relation to the emergent structural configuration of the R/D&I system (in terms of the R/D&I functions). In the "configuration" sub-issue, we are specifically interested in how the R/D&I functions are clustered (i.e.,

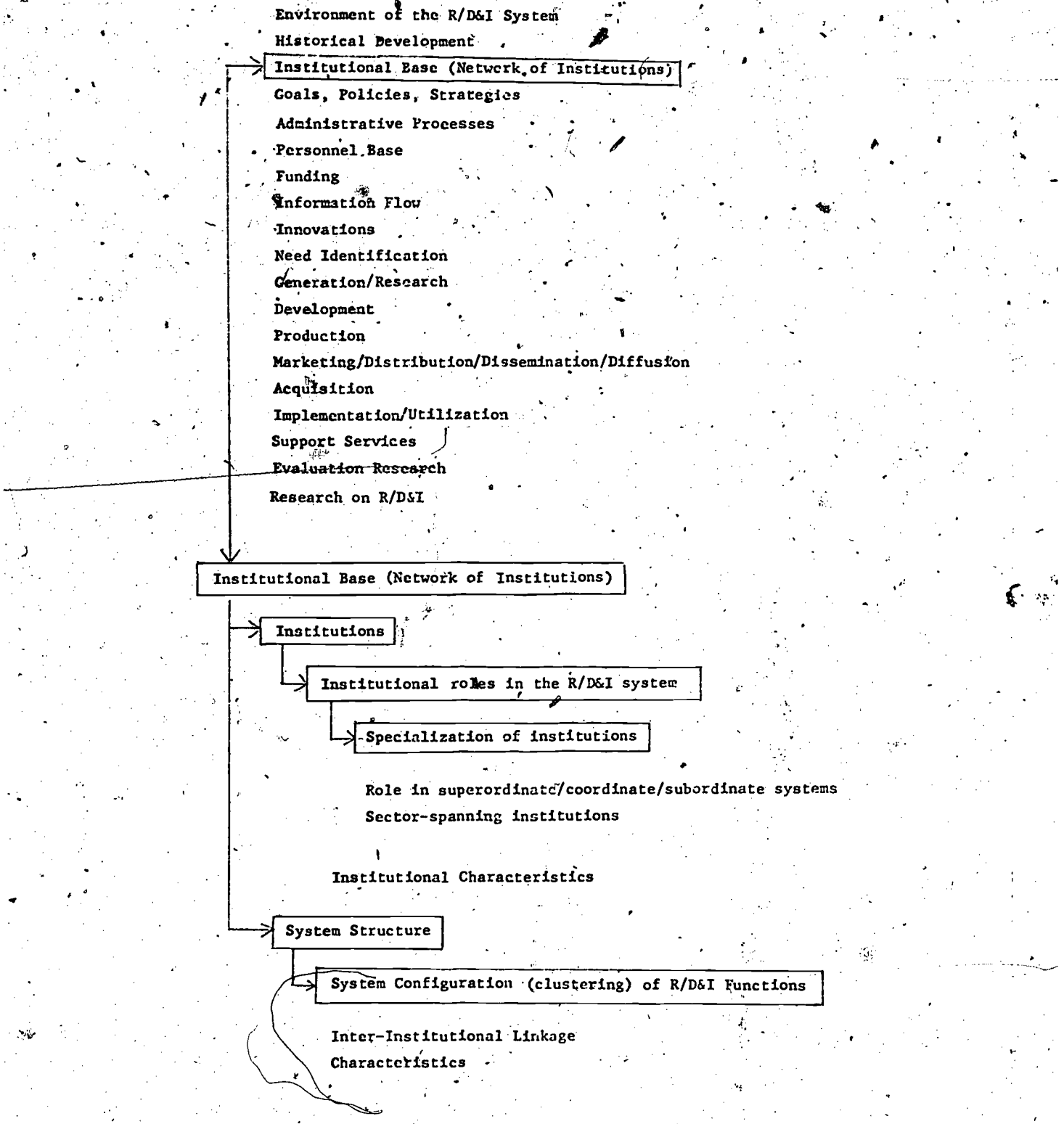


Figure 3

Selection of Institutional Base Sub-Issues for Focused Analysis

grouped together) in the various institutions. This dual perspective (specialization and configuration) of the institutional base of the R/D&I functions should provide a rich base for analysis. The process for narrowing the focus of the analysis to these two sub-issues is illustrated in Figure 3.

2. An Initial Analytical Analysis of Specialization and Configuration

We are now ready to begin our first attempt at contextual analysis for the institutional base (network of institutions) feature of the R/D&I context. The question at this point is: Do we observe, (as we look across various contexts) differences in the way that institutions operating in the R/D&I system specialize in various R/D&I functions (from need identification to utilization and evaluation research) and in the way in which these R/D&I functions become clustered in the emergent configuration of the R/D&I system? This is shown in Matrix 1 in which the specialization and configuration variables are interacted with each of the contextual features.

As always, there are interaction effects between the various features in terms of their impact, as well as second order issues. For example, Matrix 1 enumerates a whole complex of contextual requirements which will lead to the configuration of the system network taking the particular form that it might in any specific case (thereby moderating the generic requirements). But the emergent configuration itself, immediately and over time, generate a source of continuing variance. Thus the configuration may generate interface issues requiring management and policy actions. Depending on how these management and policy options are exercised, there will be a feedback influence on the configuration of the system. One example would be the creation of liaison mechanisms to help overcome interface problems and sometimes leading to the appearance of actual liaison institutions in the network of institutions. Another example has been the emergence of business incubator departments and organizations whose specific role is to overcome the interface difficulties that are common in the R&D to commercialization linkage. This general issue is diagrammed in Figure 4.

MATRIX 1

BRIEF ILLUSTRATIVE CONTEXTUAL ANALYSIS OF TWO ISSUES OF THE INSTITUTIONAL BASE FEATURE

Contextual Feature	Specialization	Configuration
1. Environment		
Political/Legal Processes	Regulations creating and restraining specialties, various innovations	Regulations, policies creating and restraining institutions
Social/Cultural Processes	Norms favoring/restraining specialties	Norms favoring/limiting certain types of institutions/relationships
Economic Factors	Differential expenditures in specialties. Economic control of specialties	Differential expenditures by types of institution. Economic control of institutions
Scientific/Technological Factors	Impact on state of arts. Type of knowledge base certainty, science/craft. Technological imperative effects	Effects on economics of scale and interface costs. Sunk cost effects
2. Historical Development		
Institutionalization	How do specialization patterns change as a field becomes institutionalized (in general and within specific organizations)?	Are there particular configurations more or less congruent with various phases of institutionalization?
Critical Events	Legal events that create specialties (needed to meet certain regulations). State of the art events that create new specialization. Funding becomes available for particular specialties.	Legal requirements for certain institutional arrangements/relations. Establishment of specific institutions. Establishment of specific cooperative relationships
Time Effects	Maturation of specialties. Paradigmatic revolutions	Organizational aging leading to organizational growth and decline. Development/decline of inter-organizational relations

Contextual Feature	Specialization	Configuration
3. Institutional Base (Network of Institutions) (other factors only)		
R/D&I Institution Characteristics	Impact on ability of certain specialties to flourish Distribution of specialties	Effects on ability and willingness to interrelate and cooperate
4. Goals, Policies, Strategies		
Strategy Development		Vertical and horizontal integration strategies
5. Administrative Processes		Management of institutional interfaces
6. Personnel Base	Effect of career patterns, and professionalism of personnel Effect of obsolescence	
7. Funding		
Constraints on use	Effect of allocation of funds for specific specializations	Support for specific institutions and and networks
Capital Requirements		Effects of economies of scale, and cost of facilities
8. Information Flow	Effect of information availability on appearance of specialties	Information distribution in the network of institutions
9. Innovations		
Requirements	Effect of state of art requirements Legal/regulatory/social constraints	Effect of level of R&D effort required
Characteristics	Effects of product/process life cycle and testability	Effects of product/process life cycle, cost, scale on types of institutions involved in network.

Contextual Feature	Specialization	Configuration
10. Need Identification Process	Effects of technology gaps	
Need identifiers	Specialization required	Appearance of specialist need identification institutions (e.g.: market research)
11. Generation/Research	Specialization required	Institutional environment and network required
12. Development	Specialization required Role of specialized incubator and spin-off organizations	Institutional environment and network required (plus effects of pilot plant requirements)
13. Production	Specialization required for productivity	Institutional environment and network required (plus effects of economies of scale)
14. Marketing/Distribution/ Dissemenation/Diffusion	Specialization required	Institutional environment and network required (plus effects of market structure and innovation diffusion)
15. Acquisition	Specialization required	Institutional environment and network required

Contextual Feature	Specialization	Configuration
16. Implementation/Utilization	Specialization required	Institutional environment and network required
17. Support Services		
18. Evaluation Research	Specialization required	Institutional environment and network required (plus effect of need for inadependent evaluation in some cases)
19. Research on R/D&I		

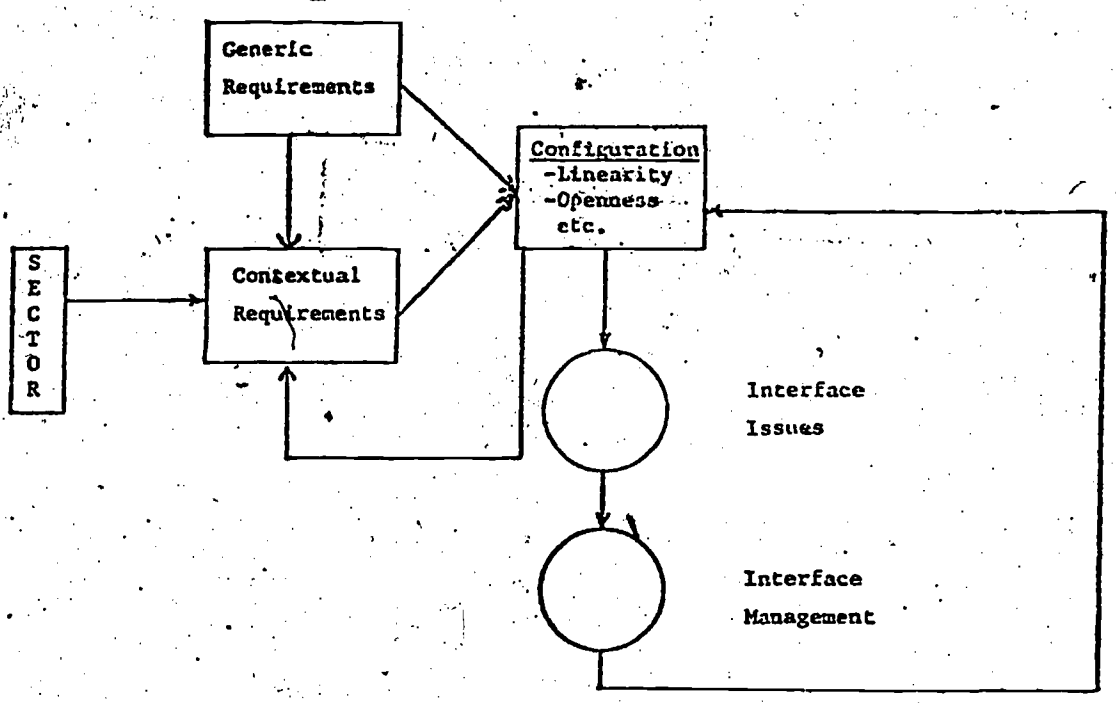


Figure 4

Relation Between R/D&I System Issue (Configuration), Sub-Issue (Interface) and Management Actions

Another interaction effect of some relevance is that between technology and institutionalization (i.e., relating the environmental and historical features). In some of our own recent research[3] we have demonstrated how an increase in the scale and investment in experimental technology can act to further the institutionalization of a field of science (in that case high energy physics) defined in terms of its industrialization, bureaucratization and shifts in professional norms from cosmopolitan to local values. Such phenomena would be related to the "technological imperative" and "sunk cost" effects already noted in Matrix 1. By such concepts we refer to the hypotheses which see scientific choices and specializations as being driven by the demands of the in-place technologies of experimentation, whether by its inherent constraints or by philosophies requiring exploitation (and/or amortization) of previous investments in technological facilities and equipment.

Returning to the Matrix 1, it is evident that the historical and environmental features of context would be a starting point of rich potential. Examination of the issues to be found in these areas indicates the centrality of such questions as the nature of the state of the arts and the legal/economic/social norms. In the light of our discussion above concerning specific interdependencies between features, it would therefore appear necessary to connect any consideration of the impact of historical and environmental context on specialization and configuration with a consideration of the professional skills and norms of the personnel involved in the process. The question of skills required for specialization can be seen to be a pervasive issue in this analysis. In selecting, therefore, a narrower area for comparative analysis we focus in on the subset of Matrix 1 area represented by the above features.

3. Clustering of R/D&I Functions as a Focus for Analysis

Further, as another simplifying step in the analysis it would be helpful to attempt to link the twin dependent variables of specialization and configuration. The question is: How do various patterns of specialization reflect themselves in the configuration patterns of R/D&I systems? Another way of stating this question is: How do the various specialties cluster together within specific institutions in the R/D&I network, hence generating the emergent configuration? In practice, of course, we do not encounter a near infinite variety of institutional forms each with its own cluster of specialties. For most practical purposes the clustering with which we are concerned is at the more macro level of the R/D&I functions that we (and most others) have described as "development", "production", etc. -- although it is to be borne in mind that a specific specialty that is to be found in "research" in one context may well be found in "development" or "implementation" in another. However, for our purposes, at least in a first analysis, it is reasonable to concentrate on the question of how the R/D&I system functions are grouped together (clustered) in the network of institutions. "Clustering" is an issue that captures much of the specialization issue. It now becomes the focus of our continued analysis.

MATRIX 2

Initial Detailing of Questions Relevant to the Clustering Sub-Issue in Relation to Three Contextual Features

Contextual Feature	Clustering
1. Environment	
Political/Legal	Are there any political/legal determinants of clustering of R/D&I functions (e.g.: legal requirements that basic research must be controlled by professional practitioners, i.e., professional regulation)?
Economic Factors	Has there been any pattern of economic support that has permitted certain R/D&I institutions to grow and absorb functions previously performed elsewhere (or not at all)? Has the overall level of economic support permitted the full development of R/D&I system functions? Have the sources of economic support legislated the clustering of functions for reasons of economic control and cost efficiency?
Scientific/Technological Factors	How does the nature of the knowledge base (state of arts) determine the emergent clustering patterns (e.g:, the effect of the ability to codify the knowledge on interface transfer difficulty)? Does increasing certainty of knowledge permit greater specialization? Are craft (as opposed to science) fields more or less likely to exhibit detailed specialization and differentiation of R/D&I system functions into separate institutions? What types of technology provide opportunities for economics of scale and how does this weigh against interface costs in determining functional clustering?

2. Historical Development

Institutionalization	What is the relationship between the level of institutionalization of an R/D&I system and the way in which R/D&I functional specialties are clustered in specific institutions? Is there a tendency towards more specialization with maturation? What is the effect of institutionalization on the evaluation process?
Critical Events: Legal/ Political	Have there been any specific legal/ political events requiring (or forbidding) specific clusters of functional specialties?
State of the Art	Have there been any state of the art developments that have significantly modified the nature of the various R/D&I system functions and hence how they are clustered together in institutions?
Time Effects	How has any gradual change in the nature of the fields of knowledge influenced the way the specialties operate and interrelate between each other (for example through increasing codification of the knowledge base)? Have patterns of cooperation emerged over time? What is the impact of institutional growth and decline on the clustering of R/D&I system functions?

6. Personnel Base

How do professional norms, career patterns, etc. determine the combinations of specialties that are found in the field with consequent impact on the clustering of R/D&I functions (e.g: do the users insist on participating and even controlling the knowledge generation process)? How is the flow of personnel into and out of fields affecting the viability of specific institutions and hence the clustering? What is the effect of differential obsolescence of personnel in various fields? What is the effect of personnel in some parts of the R/D&I system being only partially committed to their specific functional roles (e.g.: part-timers or having multi-function concerns)?

4. An Initial Contextual Analysis of Clustering in Relation to Three Contextual Features

Matrix 2 develops our analysis around the focal issue of clustering. In Matrix 2, we become somewhat more specific on the issues than in Matrix 1 - - but we now concentrate only on the historical development, environment and personnel base features of the context as they impact the clustering of R/D&I functions.

Examination of Matrix 2 would indicate that the three contextual features (environment, historical development and personnel base) are being operationalized under a number of main areas. These could be consolidated as follows:

1. Effect of the institutionalization of the field of knowledge and knowledge application.
2. Legal/political/social/economic regulation.
3. Political/social/economic support for various institutions and functions.
4. Effects of technology.
5. Nature of the knowledge base (state of the art).
6. Effect of the maturation of specialties.
7. Professional characteristics of personnel.

The above could be consolidated further into issues concerning:

1. field of knowledge and application (items 1 and 2);
2. R/D&I institutions (3 and 4);

3. functions (3 and 4);

4. knowledge base (5 and 6); and

5. personnel (7).

Further, a review of Matrix 2 reveals the implicit model diagrammed in Figure below.

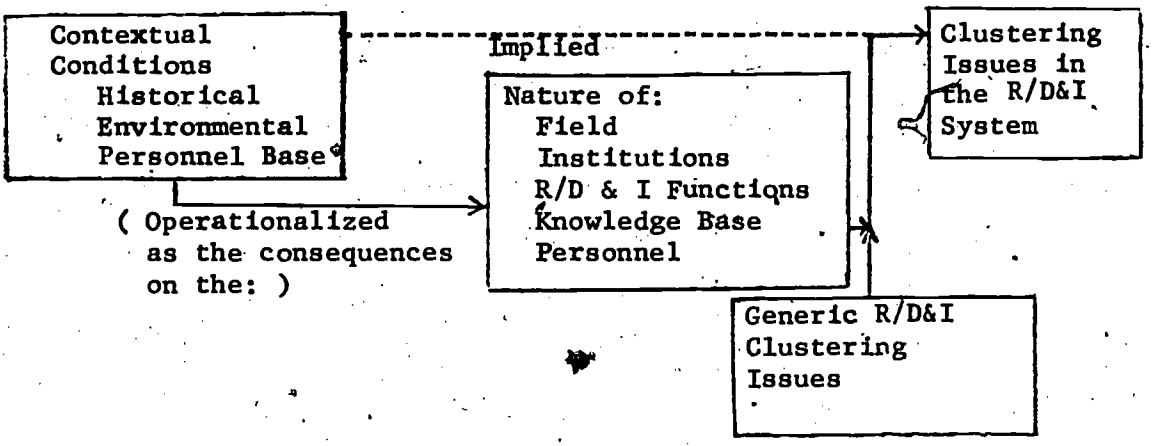


Figure 5

Impact of Contextual Conditions on R/D&I System Clustering

The dependent variable (the clustering of R/D&I functions into institutions) is relatively simple in this case. We are concerned with how the generic R/D&I functions are translated into sets of activities being performed in the various real institutions of a concrete R/D&I system. Some of the specific sub-issues would be:

1. How much specialization do we find within R/D&I functions?

2. To what extent do we find several R/D&I functions clustered together in single institutions or institutional arrangements (cooperation)?

3. In what function location in the R/D&I system (at knowledge generation, production, knowledge utilization, etc.) do we observe any such clustering?

4. Do the clusters tend to occur by the joining of contiguous or adjacent R/D&I functions or of looped (non adjacent) R/D&I functions? Are the clusters linked in serial or parallel networks?

5. Do we observe gaps in that nowhere does a given R/D&I function seem to be fully carried out?

6. Is the observed clustering stable or temporary?

7. How formal and visible is the observed clustering?

8. To what extent is it legally and socially sanctioned?

5. Selecting a Set of Clustering Dimensions and Contextual Conditions for Detailed Analysis

Matrix 3 takes our analysis a step further by relating the above dimensions of clustering to the previously discussed contextual conditions. However, while Matrix 3 in its entirety is a framework that would be proper for a full analysis of a specific case, it is still too large and requires too specific a level of knowledge to be useful for a general illustrative analysis. Specific events, regulations, etc. would be of great importance in a given case but cannot be generalized for useful presentation. It becomes necessary for us to further simplify Matrix 3.

Contextual Condition	Dimensions of Clustering								
	Specialization	Extent	Location	Contiguity vs. Looping	Series vs. Parallel	Gaps	Stability	Formality	Sanction
Institutionalization									
Legal/Political/Social Regulation									
Political/Social/Economic Support									
Technology Required									
Knowledge Base									
Maturation of Specialties									
Professionalism of Personnel Base									

Matrix 3. Contextual Analysis of Clustering of R/D&I Functions

We can do this by first selecting a subset of dimensions of clustering which we will examine. These are:

1. specialization levels;

2. the extent to which clustering of R/D&I functions takes place;

3. whether the clusters are of contiguous or looped R/D&I functions (i.e., level of contiguousness);

4. the degree to which gaps (in R/D&I functions) are to be found in R/D&I systems.

Secondly, we can also elect to examine a set of contextual conditions that captures several critical dimensions but not all the richness. Thus we can look at time effects in terms of the impact on both the system and the maturation of specific specialties. Therefore, we shall use the idea of the institutionalization of the field to denote such effects on both the system and individual specialties. Support and regulation are often interrelated and have an enormous variety of possible aspects in terms of who, how, when, why, etc. For illustrative purposes we will limit ourselves to a simpler issue, namely: Does support and/or regulation in the system come from the producers or users of knowledge and products? Stated in this way, the issue also allows incorporation of an important aspect of the professionalism condition; i.e., whether the dominant professionals in the system are to be found in the producer or user functions or both (i.e., where they exert controls). Technology will be considered only in terms of the effects of economies of scale. The knowledge base will be considered only in terms of its level of certainty (including notions of science vs. craft).

The intersection of the selected subsets of clustering dimensions and contextual conditions are reflected in the shaded columns in Matrix 3. This is not to imply that the other clustering dimensions and contextual conditions are not important, but rather that those selected do permit a useful first level of illustrative analysis and insight, and capture well the two original aspects of specialization and configuration.

6. Developing a Detailed Analysis of the Clustering Issue

We can now reformulate Matrix 3 into its simplified form as in Matrix 4. The "x's" in the cells represent hypothesized relationships between the expected type of clustering and the selected contextual conditions. Those cells for which no relationships have been indicated cannot be predicted by the individual contextual variables alone. The limitations of two variable propositions is also recognized. It is our assumption that such analyses are but a first step in an enrichment process permitting the construction of more elaborate theories and models at each step of the analysis, as is found necessary and useful.

SELECTED CONTEXTUAL CONDITIONS		SELECTED DIMENSIONS OF CLUSTERING							
		Level of Specialization		Extent of Clustering		Contiguity of Functions		Gaps in System	
		High	Low	High	Low	High	Low	High	Low
Institutionalization of Field	High	X							X
	Low		X					X	
Regulation and Support Dominated	Producer				X	X			
	User			X			X		
Technology-Economy of scale	High	X		X					
	Low		X		X				
Knowledge Base Certainty (Sci/Craft)	High	X			X	X			X
	Low		X	X			X	X	

Matrix 4. Selected Dimensions of Clustering as Determined by Selected Contextual Conditions

Matrix 4 can also be presented in the form of the model as shown in Figure 11. A complete discussion of this model and the admittedly debatable relationships indicated would be beyond the scope of this study; and, in the final analysis, validation and modification will have to await empirical testing. It is a poignent commentary that the literature has not to date focused attention on the complex of variables in Matrix 4 and Figure 6.

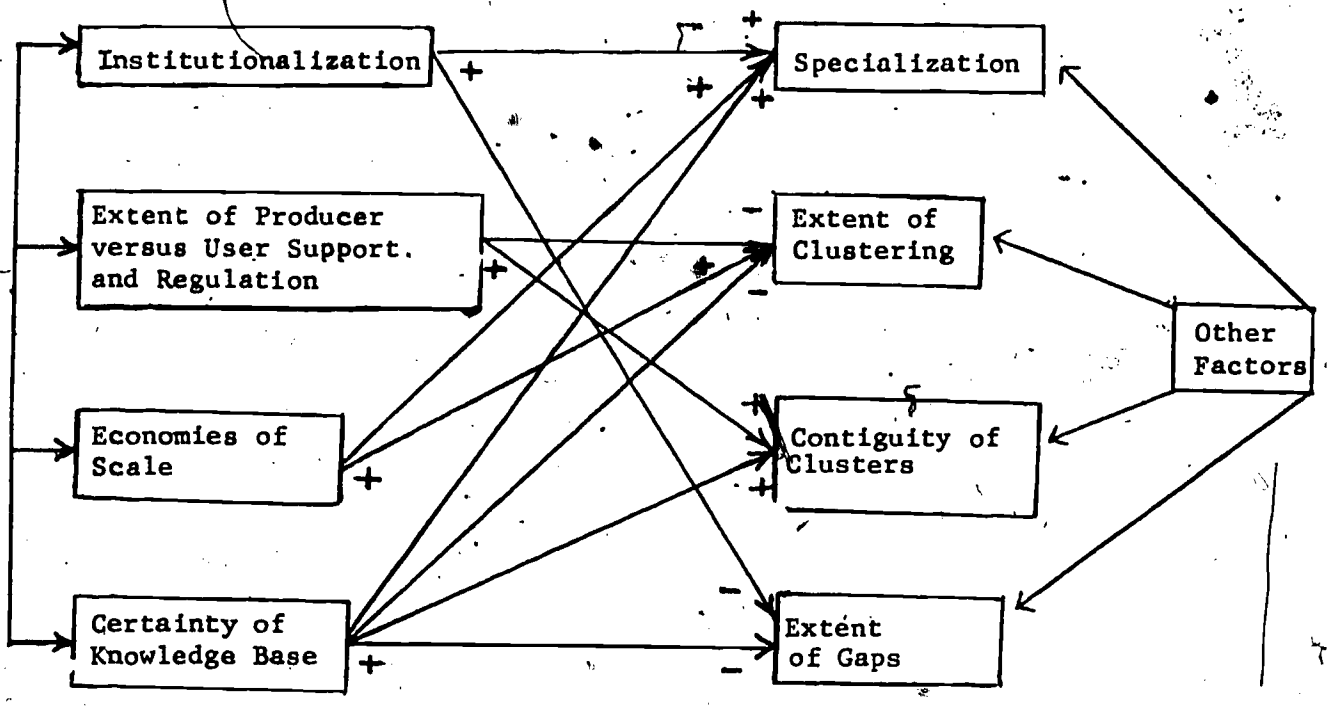


Figure 6

Contextual Determinants of Clustering Model

For now we can argue that as institutionalization progresses, there will be a tendency for specialization to grow as tasks become learned and as programmed procedures and associated facilities are developed, thereby facilitating the division of activities. Further, as specialties mature over time there is a tendency for sub-specialties to crystalize, even eventually leading to new specialties and disciplines. Increasing economies of scale make specialization more efficient. Increased certainty of knowledge facilitates and stimulates specialization by permitting codification and easier stage-to-stage transfer.

As user power (in the forms of support and regulation) grows in the system, we might expect to find users exercising control over more R/D&I functions in the system - - resulting in larger clusters of such functions. Economies of scale tend to generate the larger institutions that can exploit these opportunities, and they, in turn, are able to absorb associated R/D&I functions, thereby reducing technology transfer costs and supporting the large scale operations. On the other hand a more certain knowledge base makes it less vital that interdependent R/D&I functions operate out of the same institution.

The previously mentioned issue of increasing user power would tend to generate looping rather than contiguous clusters as users reached into the need identification and idea generation stages. A more certain knowledge base would facilitate interstage technology transfer, but the concurrent specialization would tend to stimulate a step-by-step linkage process. Similarly, interstage gaps would tend to become filled, especially as the field became more institutionalized.

The model in Figure 6 indicates another important aspect, namely the interdependence between the contextual conditions. Thus the type of regulation will tend to be related to the level of institutionalization as well as the extent to which economies of scale become exploited. In turn the rate of institutionalization will be partially determined by the problems generated by the uncertainty of the knowledge base; and so on.

The above discussion can also be presented in the form of a series of propositions

Proposition 1. The more institutionalized a field is (i.e., the more formalized, stable and mature are its institutions and specialties), the greater the specialization of activities and the fewer the functional gaps in the system.

Proposition 2. The more that regulation and support (legal, social, political and economic) is determined by the users (as opposed to producers), the greater the extent to which R/D&I functions are clustered into specific institutions and the more likely are we to find such clusters taking the form of non-linear loops.

Proposition 3. The more the technology creates economy of scale opportunities and requirements, the higher the level of specialization and the more clustered are the various R/D&I functions in specific institutions.

Proposition 4. The less certain (i.e., craft-like) the knowledge base:

a) the lower the level of specialization;
b) the greater the number of functions to be found clustered into institutions;
c) the less likely it is that these functions represent adjacent stages in the R/D&I systems model; and
d) the more likely it is that there will be functional gaps.

The model in Figure 6 also points to another consideration; namely, the indication that the four selected contextual conditions, while potentially very important, are not the only determinants of the clustering dimensions. Thus, the level of institutionalization of the system and the level of certainty of the knowledge base contribute to but are surely not the exclusive determinants of the appearance of gaps. In this case we are dealing with a variable that can be changed by deliberate and direct policy and management action. We can act to fill the gaps that tend to emerge in the given conditions.

A further review of the relationships in these propositions and the model in Figure 6 indicates four additional considerations.

1. The relationships are uni-directional. The level of certainty of the knowledge indeed helps to determine the extent of gaps in the R/D&I system, but a change made by filling these gaps will not, at least directly, have any impact on the nature of the knowledge base.

2. The contextual conditions (which are the independent variables) are essentially non-manipulable, at least in the short run. The economics of scale are there or they are not.

3. These independent variables can vary over a wide range (e.g.: from very high to very low levels of institutionalization) and at this point, we have no measures of their parameters or relative weights in the relationships.

4. There are also a great number of combinations that are possible between the variables, and (as we noted earlier) there may be other determinants of the dependent clustering conditions. It is therefore not possible to take a given clustering configuration and identify a unique contextual condition that produced it.

With these four factors in mind, we recognize that the utility of the model must come from its explanatory rather than its manipulatory power. If we can better understand why a given R/D&I system has the clustering (or more broadly, configuration) that it does, then we can avoid attempts to build or retain inappropriate system structures. Furthermore, we can determine policy options and managerial strategies that are properly adapted to the fundamental constraints of the context, rather than working at cross purposes with its natural characteristics.

We could pursue two different analysis strategies from this point. One would be to search, both deductively and inductively, for other determinants of the clustering dimensions. This would undoubtedly be productive and fascinating, and could lead to a rich theoretical understanding of the issue with important potential policy implications. It would however depart from the scope of this limited illustrative analysis.

A second and more limited strategy is to follow the partial implications of various configurations of contextual determinants into the emergent clustering and then on to the managerial and policy strategies that would seem to be congruent with that emergent configuration, given these antecedent contextual conditions. We will pursue this latter approach.

7. Scenario Case Analyses of Emergent Clustering Resulting from Different Contextual Determinants

As a first step let us examine a number of hypothetical yet realistic case alternatives in which we will establish contextual profiles and "derive" the emergent clustering. Since it is our objective here to be illustrative rather than to make a more formal cross sectoral comparative analysis we will limit ourselves to a relatively casual level of linkage into actual real world situations. Thus, we will for now need to do a minimum level of such linking to illustrate our points. We must also reiterate the points noted above: we do not know the appropriate weighting of effects across the contextual features nor do we imply that these are the only variables influencing the emergent cluster. Thus the following analysis should be understood as an examination of partial effects that would tend (although we would expect significantly) to influence the observed clustering in approximately the "derived" direction. We will then go on to discuss the implications in each case for management strategies. These cases are shown in Figure 6.

A simple analysis method has been used. A simple rating system (from very high to very low and using equal intervals) was set up for each contextual condition and the relative weighting across variables was assumed to be equal. This latter assumption appears as reasonable as any other at this time and would need to await empirical investigation to be modified. A series of hypothetical case examples (A through F) were set up and the net scores for each of the clustering dimensions was calculated (using the relationships indicated in the model in Figure 6 and simple arithmetic computation). These net scores were converted back to a very high to very low scale according to the table shown (which allows for the fact that some of the clustering dimensions are influenced by two and some by three contextual variables). The resultant (or hypothesized) dimensions of clustering are indicated in each case in Figure 7.

Contextual Conditions VHi Hi Med Lo VLo +2 +1 0 -1 -2	Cases A	B	C	D	E	F
Institutionalization	VLo -2	VHi +2	VHi +2	VHi +2	Lo -1	Med 0
Producer (vs. User) Regulation	VLo -2	VHi +2	Med 0	Med 0	Med 0	Lo -1
Economics of Scale	VLo -2	VHi +2	VHi +2	Med 0	VLo -2	VHi +2
Certainty of Knowledge Base	VLo -2	VHi +2	Hi +1	Hi +1	VLo -2	Hi +1
Derived (hypothesized) Dimensions of Clustering*						
Specialization	VLo -6	VHi +6	VHi +5	Hi +3	VLo -5	Hi +3
Extent of Clustering	Hi +2	Lo -2	Med.+1	Med -1	Med 0	Hi +2
Continguity of Clusters	VLo -4	VHi +4	Hi +1	Hi +1	Lo -2	Med 0
Extent of Gaps	VHi +4	VLo -4	VLo -3	VLo -3	VHi +3	Med -1

*Due to the possible range of ratings and the varying number of independent variables the ranges across clustering dimensions will vary. The following conversion table has been used.

For Dimensions	VHi	Hi	Med	Lo	VLo
Specialization & Extent of Clustering	+6 to +5	+4 to +2	+1 to -1	-2 to -4	-5 to -6
Contiguity of Clustering & Extent of Gaps	+4 to +3	+2 to +1	0	-1 to -2	-3 to -4

Figure 7

Comparative Hypothetical Cases of Clustering Characteristics as a Consequence of Varying Contextual Conditions

We must recall our previous cautions. The indicated clustering dimensions can only be considered indicative and illustrative but can, we we will now demonstrate, provide some provocative insights.

i. Case A

Cases A and B represent the two extremes. In Case A we see what we could term a highly underdeveloped R/D&I context. The system has not proceeded far in becoming institutionalized. The knowledge producers lack any control and regulation over the system, no economics of scale have developed in a craft-like field (i.e., a field with a highly uncertain knowledge base). While undoubtedly exaggerating in some aspects (particularly as regards the extremes of low institutionalization and user control) one cannot but help thinking that the educational R/D&I system until very recently almost fit this description. (Though as we will note, Case E perhaps more closely reflects the educational R/D&I system). The criminology aspects of the law enforcement R/D&I system also might almost be included in this category.

If we move down Figure 7 to examine the implications for the R/D&I system clustering for Case A we would be hypothesizing a very low level of specialization but a very high degree of clustering together of R/D&I functions into a consequently small number of institutions. However, these institutions would not be involved in sets of adjacent roles from basic research through development through production to implementation, etc. - - but would rather tend to unite combinations of (for example) development and utilization (or even basic research and utilization); or development, marketing and evaluation research; and so on -- and importantly, would be leaving many R/D&I functional areas virtually undealt with (i.e., there would be many gaps). Such an R/D&I system structure would indeed seem to be congruent with the "underdeveloped" description we gave to the contextual environment, and, again in many (though not all) ways reminds us of some parts of the education and law enforcement sectors mentioned above. At least then, in terms of a relatively casual empirical basis, there would appear to be some face validity to our schema as far as this has emerged from the Case A discussion.

ii. Case B

Case B, by contrast, represents a highly institutionalized system controlled by the knowledge producers. Economics of scale and certainty of knowledge base are high. These conditions remind us of those to be found in the industrialized high technology hardware sectors (e.g.: automotive, aircraft, etc.). Also characteristic of the types of industries mentioned above are the hypothesized clustering characteristics of high levels of specialization in a relatively large number of institutions following highly linear progressions of functions and leaving few or no gaps.

iii. Case C

Case C varies from Case B only in that there is a relative balance between users and producers in their level of control over the R/D&I system as compared to the very clear producer control of the previous situation, and a somewhat reduced level of certainty in the knowledge base. The consequences for the emergent clustering are found in a diminished linearity and a somewhat reduced number of institutions. With the very high level of institutionalization, the high economics of scale, and a seeming balance between the powers of producers and users, this case might remind us of the more industrialized segments of the health sector (e.g.: the drug industry). The high but not total level of certainty of the knowledge base may also fit. The hypothesized high specialization and the low gaps left by the medium sized and modestly looped institutions again fits the drug industry.

iv. Case D

Case D varies from Case C only in taking the economics of scale to a lower level with the effects of generating somewhat smaller clusters and institutions with a little less specialization. The difference might be explainable by reduced markets or less developed production technologies (e.g.: even the same drug industries in less developed edonomics; or perhaps the agricultural industry).

v. Case E

The context for Case E possibly reflects that of the educational sector better than our speculation for Case A. Economics of scale and certainty of knowledge base are still very low, but we observe a less powerful user group though a somewhat higher (though still underdeveloped) level of institutionalization of the R/D&I system in its sector. The hypothesized clusters are still looped rather than contiguous but in not quite as extreme a manner as in Case A and the sizes of the institutions are somewhat smaller. Again these characteristics seem to represent an even better description of the actual situation in education, and the criminology example given above.

vi. Case F

Case D was described as a form of Case C, but operating in a possibly less developed environment. Case F could also be seen as a less developed form of Case C, but this time in terms of a lower level of institutionalization and reduced level of producer power in the system. One could readily see how a Case F context could mature over time into a Case C profile. We could therefore be talking about either an earlier stage of development or a less developed segment of a sector. Thus we might associate Case F with the medical procedures or the preventive medicine R/D&I programs of the health field. The hypothesized level of specialization is lower, the extent of clustering greater, gaps are more common and the configurations far less clear and linear -- all characteristic signs of a less developed condition. The differences as opposed to the previous drug segment of the health field, at least in a preliminary way, do seem to concur with observation.

So far, then, we have been able to demonstrate that the selected contextual conditions do seem capable of providing a realistic and rich description of varying real world situations and, more importantly, that the hypothesized clusteral configurations do not depart dramatically from those that

seem to be observable in the same real world situations. Further, the more realistic we make the contextual descriptions, the more realistic seem to become the descriptions of the configurations. Finally we have seen that the model realistically reflects that as dynamic developmental changes in context occur over time, these changes are reflected in emergent structures. Even while remembering our previous cautions, these are encouraging findings. If we can hope to develop such a level of insight from comparative contextual analysis, we may hope to continue productively to the next step of exploring some managerial and policy implications for R/D&I sustems.

8. Initial Analysis of the Implications of Contextual Determinants of Emergent Clustering for Management/Policy Strategies.

A number of management issues can be identified which relate to these various R/D&I system configuration patterns. For example, a key generic R/D&I issue is that of determining appropriate start and stop points for programs in the work flow sequence. Frequently, research personnel are loath to let go of the project "children" to whom they have given birth. Sometimes they can be observed holding on to programs well into production and even marketing stages, long after they should have either passed the project on to others for development, etc., or abandoned it. Issues of judgment, appropriateness of skills and efficient use of talents are involved. While this is always a problem, it would be likely to appear in different forms in the various above cited cases. In Cases B, C, D and to a degree F such behavior is likely to be more visible and clearly more incongruous to the role of researcher than in the Cases A and E, where role definition is far less clear. Thus, in Cases B, C, D and F, it may be more easily recognized and managed. In turn such behavior may even be seen as a virtue in the Case A and E contexts (although the previously mentioned issues are likely to remain). We will return to this question again. A related question is the classic Not-Invented-Here syndrome which is likely to appear in more aggravated forms where R/D&I functions are highly specialized and differentiated (as in the Cases B and C).

Another example of a pertinent management question could be in the differential utility and applicability of various management techniques such as PERT. The high degree of task, function and role definition to be found in the Case B and C contexts make the application of such a method very rational. Tasks can be specified and deliniated; resource and time requirements can be estimated to a reasonably acceptable level of accuracy and reliability. Such may be far from the case for Cases A and E. As a consequence, attempts to transfer this technology (which was developed in the more definitive aerospace/military/industry contexts) to the world of education (for example) without appropriate review and redesign for the changed context was bound (as it did) to lead to misapplication and disappointment.

The use of Delphi techniques to obtain estimates of complex and uncertain phenomena (frequently of an environmental nature; e.g.: for forecasting purposes) within institutions is another good example. The problem is to find a series of R/D&I "experts" who can see beyond their immediate task and time environments. (1) In cases such as B and C, this may not be so easy, because R/D&I personnel are all too often limited in their perspective by the very specialization that makes them productive. In contrast, in cases like A and E there is a much greater tendency for personnel to be generalists - - in fact, the normal decision processes are essentially Delphic, thereby making the use of such an approach (while relatively easy) almost pointless.

The management of functional interfaces is another area of comparative interest. In highly specialized and differentiated institutions, there are many interfaces to cross between groups with relatively well defined and impermeable boundaries. Coordination becomes a major issue, often calling for liaison mechanisms, etc. This would seem to be likely to occur in cases such as B and C. In contrast, Cases A and E would have far fewer interfaces to cross, many functional overlaps, and generally fuzzy boundaries between activities. Potentially offsetting these helpful effects would be the factors of lack of linearity, which might make interface differences (of perspective and discipline) larger to overcome - - with the existence of functional gaps creating transfer problems between certain R/D&I functions. As we saw

earlier, such shortcomings usually accompany the very same cases that have the lower number of interfaces to deal with, as in Cases A and E. In summary, we would tend to find differing types of interface problems across varying R/D&I contexts, but not necessarily any overall greater or lesser problems; and this indeed seems to be the general experience.

9. Detailed Analysis of the Implications of Contextual Determinants of Emergent Clustering for Three Selected Areas of Management Concern

Similar discussions could be presented to cover a wide spectrum of R/D&I management issues and techniques, but this would be beyond our present illustrative purpose. Rather, we now select the above noted management issues and methods which we will examine somewhat more formally in terms of our present concerns with the importance of the context/clustering nexus. These were selected because they appear to cover a broad spectrum of areas of management concern. The selected areas are:

1. Methods of Program Control (including such techniques as PERT as discussed above). This area deals with the control of work and activity flow within an R/D&I institution.

2. Interface Management, which is concerned with the linkages within institutions.

3. The use of Delphi type techniques in relation to issues of an institution's relationship with its environment (in terms of goals and forecasts).

These three topics provide us with a wide ranging sample of managerial issues of both an internal and external R/D&I system nature.

Matrix 5 is an attempt to relate the ease or difficulty in using or dealing with the above three R/D&I management approaches and issues to the four dimensions of clustering previously discussed. The over-simplification is

Matrix 5. Use Characteristics of Selected Management Approaches in Varying Clustering Conditions

Use of Selected Management Approaches	Dimensions of Clustering							
	Special-ization		Clustering		Contiguity		Gaps	
	High	Low	High	Low	High	Low	High	Low
1. Program Control								
Difficult		x		x		x	x	
Easy	x		x		x			x
2. Interface Management								
Difficult	x			x		x	x	
Easy		x	x		x			x
3. Use of Delphi								
Difficult	x			x	x		x	
Easy		x	x			x		x

again recognized and calls for both enrichment and validation by empirical research. This should be carried out, but the indicated relationships have a face validity.

For example, Program Control is rated as being difficult under conditions of low specialization and vice versa. As was earlier implied, the lack of certainty attached to stage-by-stage tasks in an R/D&I process makes it difficult to define the task requirements, etc., and hence to use methods such as PERT. The more R/D&I functions that can be found clustered together within a single institution, however, the easier it becomes to develop and maintain a program plan, since one is dependent on fewer difficult to control and forecast external agents (often a major problem in PERT systems). The more linear the relationships between R/D&I functions (high contiguity), the easier to plan and predict the progress of the step-by-step progression. Finally, the increasing incidence of system gaps

progressively adds uncertainty to the process, making the use of programmed methods of control more difficult.

We have already discussed most of the relationships concerning Interface Management. As regards the extent of clustering, we could expect that interface problems would be relately easier within rather than between institutions, and hence favorable for the case of higher clustering levels. Also Delphi methods would, as we noted, be easier in low specialization organizations, and we would expect similar experience in larger, looped (non-contiguous) institutions with few gaps (i.e., those institutions having broader, more interdisciplinary and complete perspectives among personnel).

Using the above relationships we can now examine the varying implications for the six previously discussed cases (A through F). Referring back to Figure 7 and Matrix 5, and once again using a simple computational approach, we can combine the various ratings of the clustering dimensions (in Figure 7) with the suggested implications for the management issues in Matrix 5 (using the same scoring procedure: V Hi + 2 to V Lo - 2). Thus in Figure 7, Case A was shown as V. Lo on specialization, which would lead via Matrix 5 to a "very difficult" (VDi) rating on Program Control with a -2 score. Similarly the High extent of clustering for Case A generates an "easy" (E) implication with a score of +1, and so on. The net scores are then reconverted for each management issue for each case.

This reconversion is shown in Figure 14. We have also computed the overall scores and ratings as an attempt to estimate the extent of the "management problem" for each case.

From Figure 14 we observe that Program Control was rated as easy for Cases B, C, and D (essentially the high specialization, low gap cases) and difficult in Cases A and E (the converse cases). That is, the highly developed R/D&I systems (which as we suggested could be descriptive of the automotive, aircraft and drug industries) were ideal environments for such methods as PERT. We had described Case D as somewhat less developed, and although the differences were small, the slight change would indicate a possible degree

Use of Selected Management Approaches	Cases					
	A	B	C	D	E	F
1. Program Control	-5 Di	+5 E	+5 E	+4 E	-5 Di	0 Med
2. Interface Management	-1 Med	+1 Med	+1 Med	+2 Med	-1 Med	0 Med
3. Delphi Methods	+3 E	-3 Di	-1 Med	+2 Med	+1 Med	0 Med
4. Overall Management Problem	-3 Med	+3 Med	+5 Med	+8 E	-5 Med	0 Med

Items	VE	E	Med	Di	VDi
1-3*	+8 to +6	+5 to +3	+2 to -2	-3 to -5	-6 to -8
4**	+24 to +16	+15 to +6	+5 to -5	-6 to -15	-16 to -24

E = Easy

Di = Difficult

* (Product of 4 variables)

** (Product of 4 variables by 3 cases)

Figure 8

The Use of Selected Management Approaches in Six Comparative Cases

of greater difficulty. The less developed R/D&I systems in Cases A and E (education or law enforcement perhaps) are seen as being much less suitable environments for such approaches, with the intermediate Case F (e.g.: preventive medicine programs) being a quite unsuitable environment. In general, this seems to concur with experience.

When we turn to Interface Management, no such differences appear. As we suggested earlier the offsetting factors in each situation generate a net balance in each case (although this may be an artifact of our equal weighting procedure - - this would require empirical study). While we are not confident of the meaning of a medium rating across the board, the relative similarity across the cases is as we tend to observe it. Experience tells us that interface management is a problem everywhere; and it has not been our experience that it is an especially greater problem in any particular context as compared to others. Thus, instead of being concerned with differences in the weight of the problems across cases, we would be more concerned with differences in the specific issues and the points where the issues occur as these relate to differences in contexts.

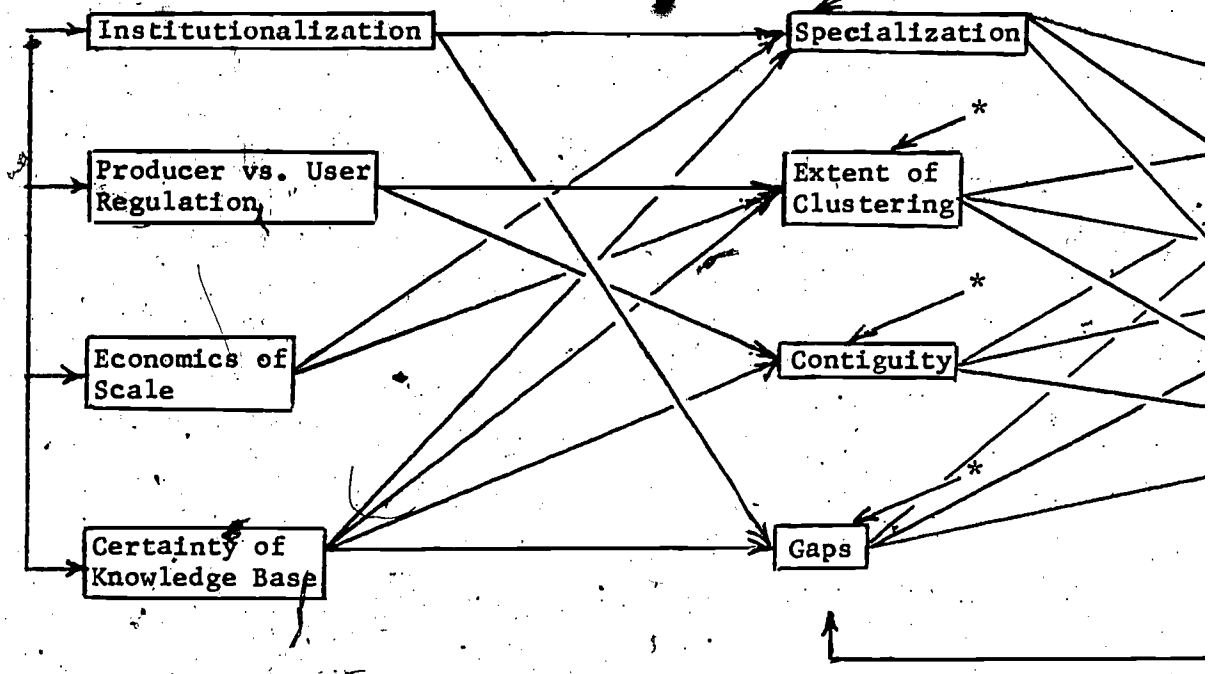
The use of Delphi reflects neither of the first two patterns. Cases A and B (the extreme cases) show the greatest difference (as expected), but Case C with its larger and less linear clusters provides a better environment than Case B (a difference not to be observed for Program Control). Case D is a better environment yet, reflecting the lower specialization. The difference between Cases A and E appears to mirror the shifts between Cases B and C. Apart from the shift between Cases A and B, the overall impression is that the Delphi approach is usable in most environments, to a degree, but does better as the contexts become "fuzzier" (as many proponents of the methods have contended - - as for example in recommending its application to government policy making). (1)

The ratings for the overall management problem are especially interesting in their uniformity, with a single possible exception, Case D (although even there the difference is not dramatic). The common language and

practically stated interpretation of this result could be: "While the specific management problems across the various situations may be different from each other, in total they do not add up to a substantially greater or lesser problem." Whether such an hypothesis could stand up under empirical study is still an open question, but the suggestion is provocative and one that we have not seen spelled out in this (or any other such) manner before.

Finally, we must link back to the contextual conditions that generated the case clustering conditions. The clustering profiles that we used to analyze the management approaches issue were derived as a product of the contextual conditions profiled in the top half of Figure 7. Thus, in fact it is to those contextual profiles that we are connecting the above management implications. That is, we could say that in contexts such as Case A (i.e., with low levels of institutionalization, high user/low producer regulation, few economics of scale and an uncertain knowledge base), formal Program Control methods such as PERT will work only with difficulty, Delphi methods with relative ease, and interface management will present no unusual problems (beyond the norms).

This process of linking of contextual conditions with management implications could be repeated for the other cases. In the model in Figure 9 we show how the contextual conditions link into the applicable management processes through the profile of the clustering of R/D&I functions in the instituions in the R/D&I system. The model also indicates one more point that was made earlier, and with which it is appropriate to conclude this discussion. This is that unlike the contextual conditions which acted as relatively unchangeable parameters, the management processes used could have a significant impact on the clustering (configuration) of the R/D&I system, creating the earlier discussed dynamics. Obviously this does not apply equally to all management actions, and in the cases reviewed it would be Interface Management that might be expected to have the major impact. The point to be made is that management actions can influence the situation, but these must be selected so as to be appropriate to the context in which they will be used.



Contextual Dimensions

Clustering Profile

*Other factors

**Management Actions

Figure 9

Model Relating Comparative Contextual Dimensions, Cl
and Applicability of Management Proces

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CHAPTER NINE

ENTREPRENEURSHIP:

AN ISSUE OF THE HISTORICAL DEVELOPMENT FEATURE

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CHAPTER SEVEN

ENTREPRENEURSHIP:

AN ISSUE OF THE HISTORICAL DEVELOPMENT FEATURE

INTRODUCTION

In the preceding chapter, we illustrated the use of the contextual analytical framework in relation to the contextual feature: institutional base. In this chapter, we will similarly illustrate the use of contextual analytical framework in relation to a specific issue of the historical development feature: the role of the entrepreneur in the historical development of R/D&I systems.

This issue was selected through a process of progressively narrowing down from the historical development feature. That discussion is contained in the full report. Essentially, this involved the identification of a factor that has been observed to be of critical importance in the dissemination, transfer and implementation of innovations, especially in less than fully matured R/D&I systems. Thus in the earlier phases of the life cycle of R/D&I systems the need for "product champions" or "entrepreneurs" has been shown to be of vital importance in the "success" of new product and process innovation introductions and adoptions.(2, 3, 8)

The issue of entrepreneurship is presented as one illustration of the several such issues analyzed in the full report. Our purpose is to demonstrate the process by which such a question can be examined from the generic perspective, leading into a potential comparative analysis across several contexts. In this analysis the contexts will be hypothetical, but the extension to real world conditions should be relatively self evident.

The analysis will follow a "reductionist" methodology. On a step-by-step basis, we will gradually narrow the focus of the analysis of the "entrepreneurship" issue until we have reached a level of analysis which is limited enough for an analysis to be manageable yet still rich enough for meaningful illustrative policy analysis. In the

process of narrowing the focus of analysis, we shall "carry along" significant aspects of a fuller contextual analysis to enrich a more specific illustrative policy analysis. Additionally, we shall have created a "footpath" whereby a more specific illustrative policy analysis may be "led back" into an interaction with the fuller contextual analysis.

To further enrich the specific illustrative policy analysis, we will provide a comparative analysis across three sectors from empirical case studies.

To begin our narrowing of the focus of analysis, we will limit our analysis to the following:

1. the producer (or developer/producer) as entrepreneur (recognizing that entrepreneurs may also be users, disseminators, etc., but omitting these from this analysis);

2. the early phases of historical development of R/D&I system (through a very limited comparison will be made with a more mature stage of the innovation process).

I. THE PROCESS OF CONTEXTUAL FEATURE ISSUE ANALYSIS: NARROWING THE FOCUS

1. A "Full" Contextual Feature Issue Analysis

We have defined "context" as the interactive effect of the whole set of R/D&I system features. To permit full analysis of the feature issue of "entrepreneurship" in R/D&I systems as a function of context variation, it would be necessary to interact this feature issue with each of the R/D&I system features and feature issues. That is to say, we would initially explore the set of research and policy questions that emerge from the interaction of entrepreneurship as an issue with,

for example: historical development (the role entrepreneurship plays in the institutionalization process; how it functions in the various developmental phases; what happens to entrepreneurs over time; etc.); environment (what are some of the legal/political constraints that may operate on the entrepreneur); comparing the development, production and marketing/dissemination sub-systems (how might the type of skills required differ across the various functions of an R/D&I system). Thus a complete analysis across every feature of an R/D&I system context would be necessary to establish a basis for the full contextual analysis. This is illustrated in outline form in Matrix 1.

Matrix 1 provides an illustration, in outline form, of how such a full contextual analysis could be done. In this first instance, Matrix 1 is a first cut at the process and relies on the knowledge and experience of the analysts -- with the recognition that the analysis is likely to be improved through a series of iterations, as more is learned. There are clearly, therefore, advantages to the use of interdisciplinary and intersectoral teams in the process. From a pragmatic perspective, it is vital to avoid becoming bogged down at this point by concerns with exhaustiveness or the desire to include everyone's favorite perspective.

2. Delineation of Key Issues and Characteristics

A. Extracting Key Issues from the Full Contextual Analysis

A complete and systematic analysis of each cell of Matrix 1 that would be grounded in the literature is beyond the scope of this review. Furthermore, such an exhaustive approach would not be practical for policy making. In order to focus in on questions of both high priority and of general applicability to the area of particular concern (in this case entrepreneurship in R/D&I systems), it is necessary to narrow down the range of issues to be analyzed.

MATRIX 1:

ILLUSTRATIVE FULL CONTEXTUAL ANALYSIS OF ENTREPRENEURSHIP ISSUE

FEATURE	ENTREPRENEURSHIP
1. Environment	Legal/political constraints Impact of norms and values Economic constraints Funding priorities Technological requirements Knowledge base
2. Historical Development	Role in institutionalization Which phase needed Establishment of institutions Impact on acceptance
3. Institutional Base (Network of Institutions)	Entrepreneur as linking agent Effect of boundaries -- skills required Effect of structure, configuration, size, varying entrepreneur role legitimacy Level of sponsor support
4. Goals/Policies/Strategies	Effect of goal setting Time horizon of goals Perception of goals
5. Administrative Processes	Control of Mobilizing support and resources
6. Personnel Base	Recruitment and selection Career patterns Professionalism Obsolescence Training and development Distribution of expertise Status Motivation and satisfaction

FEATURE	ENTREPRENEURSHIP
7. Funding	Constraints on use Level (support for)
8. Information Flow	Role Information seeking skills
9. Innovations	Life Cycle Impacts and benefits - role Effect of character of the innovation (or product)
10. Need Identification	Role Skills required Responsiveness to user demands Institutional base Position Personal characteristics
11. Generation/Research	Role Search skills Tech transfer role Information flow role
12. Development	Role Skills

FEATURE	ENTREPRENEURSHIP
13. Production	Role Skills
14. Marketing/Distribution/ Dissemination/Diffusion	Role Skills
15. Acquisition	Role of key personnel Product champions Skills of user personnel
16. Implementation/ Utilization	Role of key personnel in implementation Producer/user relationship Producer characteristics Implementation capability User characteristics Innovation entry points Barriers (overcoming) In-house capability Role of entrepreneurs in utilization User relationships with sources of innovation User characteristics influencing acceptance of innovation
17. Support Services	
18. Evaluation Research	
19. Research R/D&I	

This is done by extracting those key issues which surface from the overview of Matrix 6, in the sense of being either critical or pervasive across many dimensions of the R/D&I system context. As a first step towards the definition of key policy issues, it would seem reasonable to concentrate our further effort on these issues. In this case we can identify the following:

1. the role of the entrepreneur as this shifts across the various functions of the R/D&I system (development, marketing, etc.);
2. the skills and characteristics of entrepreneurs;
3. the entrepreneur as a link between the knowledge producers and users (with special reference to the problems of need identification, implementation and utilization).

We must reiterate that these are certainly not the only issues that might be of concern to the researcher, manager or policy maker. Others can and (as necessary) would be selected. These are, however, issues that from our analysis of Matrix 1 appear to be of general and sustained importance across R/D&I systems, and hence worthy of some priority for a first (and illustrative) analysis.

B. Selection of Key Entrepreneur Characteristics

To provide a sharper focus for analysis of these key issues, it will now be useful to describe a set of entrepreneur characteristics for more detailed consideration. We select (from Matrix 1 in a summarized form) those five entrepreneur characteristics which it would appear have a critical impact on the key issues as we have identified them:

Orientation - Is the focus of the entrepreneurship local or cosmopolitan?

Perspective - Is the emphasis a theoretical or applied; on innovation or on utilization?

Legitimacy of origins - What is the impact on legitimacy if the source of entrepreneurship is external to the user organization; whether the source is peripheral or core?

Institutional Role location in system - Where is the primary entrepreneurial activity to be found: in the core or at the periphery of the producer organization.

Skills - What type of skills are required in performing entrepreneurial functions: need identification, marketing, consulting/service, development:

C. Interactive Analysis of Key Entrepreneur Characteristics

Further, it will now be helpful to examine the interaction between the entrepreneur characteristics to determine their independence, robustness and general causal direction -- as is illustrated by Matrix 2.

The implications of the Matrix 2 are that:

1. There is a mutual interaction between orientations and perspectives. In fact, these would seem likely to be highly inter-correlated concepts which are (for our policy purposes) of only marginal difference. Thus we can elect to collapse these into a single compound variable: "orientations/perspectives".

2. Skills (which were defined in terms of need identification, search, R&D (developmental), marketing and consulting service skills) seem similarly to be likely highly correlated with orientations and perspectives; but on both theoretical and practical grounds (manipulability), it seems desirable to maintain this variable separately in the analysis. This possibility of manipulability of the skills variable (through recruitment and training) may be particularly significant.

MATRIX 2:

THE INTERACTION OF KEY ENTREPRENEUR CHARACTERISTICS

	Orientations	Perspectives	Legitimacy	Location	Skills
Orientations					
Perspectives	← ↑				
Legitimacy	←	←			
Location	← ↑	↑	↑		
Skills	← ↑	← ↑	↑	←	

Legend: = general causal direction*

3. Institutional role location seems most clearly to be an independent variable in determining orientation/perspective and legitimacy. The impact of role location must be seen in terms of the types of skills that are required in a given role location as well as in terms of skills that might be acquired. It is also possible to think in terms of role location having been determined in response to available skills and orientations/perspectives of personnel -- although this seems less likely from a pragmatic policy perspective.

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* The general causal directions indicated in Matrix 2 are derived from our general knowledge of the relevant literature. In a more complete analysis, we would discuss the relevant literature from which these causal directions are derived. To do so here, however, is beyond our intention of providing an illustrative analysis

4. The legitimacy of the entrepreneur is likely to be determined by orientations/perspectives, skills and role location. Thus to most users, an entrepreneur with local/applied implementation orientations/perspectives, having the perceived necessary skills, and working from an acceptable institutional role location is likely to be invested with the necessary legitimacy to perform the role. An acceptable role location would be determined by the history of prior success and trust generating relations, and perceived authority and appropriateness.
5. In general the variables in the matrix (allowing for the collapsing of the orientations/perspectives set) appear robust and this encourages us to take the next analytical step.

3. Contextual Analysis of Key Entrepreneur Characteristics

We are now ready for a "second cut" contextual analysis in which we will again consider the implications of entrepreneurship across each of the features of the R/D&I system. This time, however, rather than considering entrepreneurship in general (as we did in Matrix 1), we will consider a much more narrow issue. Specifically, we will consider the implications of the interaction between each of the key entrepreneur characteristics (orientations/perspectives, legitimacy, location and skills) and each of the contextual features. At this level of detail, we will begin to see the potential for policy options emerging from the analysis, although some further narrowing in focus may still be helpful. Matrix 3 represents this "second cut" contextual analysis.

MATRIX 3:

CONTEXTUAL ANALYSIS OF ORIENTATIONS/PERSPECTIVES, LEGITIMACY, LOCATION, AND SKILLS

R/D&I System Features	Orientations/ Perspectives	Legitimacy	Location	Skills: Developmental Marketing Need ID & Search Consulting/Service
1. Environment	Interaction with norms & values of users	Interaction with norms & values of users	Economic & political regulations & constraints	Impact of technological requirements and knowledge base
2. Historical Development	Change over time and phases of development	Change over time and phases of development	Observed changes over phases of development	Changing requirements over time and phase
3. Institutional Base		Variation of role legitimacy across institution type Sponsor support Producer/user coalitions	Effect of boundaries, configuration, size	Organizational and inter-organizational skill requirements
4. Goals/Policies/ Strategies	Impact of goal perception differences and interaction with perceived value of the innovation to users	Impact of goal setting processes, goal conflict	Impact of goal difference in various locations	Skills required for varying goals

R/D&I System Features	Orientations/ Perspectives	Legitimacy	Location	Skills: Developmental Marketing Need ID & Search Consulting/Service
5. Administrative Processes			Ability to control Ability to mobilize resources	
6. Personnel Base	Motivation & satisfaction		Effect of level of funding constraints on use	
7. Funding	Effect of availability of user resources on entrepreneur motivation		Effect of level of funding constraints on use	
8. Information Flow			Effect of location on place in communications net	Information seeking skills. Effect of on skills needed
9. Innovations				
10. Need Identification	Personal characteristics. Perceived need for innovation	Responsiveness to user demands	Institutional base & position and ability to see needs.	Skills to recognize application needs and potential means of satisfaction
11. Generation/ Research		Constraints on tech. transfer	Location in information flow	Search skills Tech. transfer skills
12. Development 13. Production 14. Marketing/etc.		Differences across functions	Differences across functions	Skills required
15. Acquisition				

16. Implementation/ Utilization	Entrepreneur/user interaction of orientations/perspectives on implementation/utilization	Importance of legitimacy on implementation/ utilization Expected barriers	Impact on linking role. Relation to user entry points	Skills required Interaction with user skills
17. Support services				
18. Evaluation Research				
19. Research on R/D&I				

A preliminary review of Matrix 3 indicates areas that appear especially fruitful for comparative contextual analysis. Thus environment, goals, institutional base, need identification, implementation/utilization and personnel base seem to provide a rich basis for contextual variation across the four areas of entrepreneur attributes under examination. Further, while Matrix 3 has been developed in terms of each of the four selected entrepreneur attributes, we must recognize the interdependencies indicated in Matrix 2.

4. Delineation of Key Factors

With the above comments in mind, we can now identify several unifying factors (or themes) which appear to be critical sources of contextual difference and which can be extracted across all the contextual features as analyzed in Matrix 3 -- but with special attention to environment, goals, institutional base, need identification, implementation/utilization and personnel base.

1. Entrepreneur/user interaction in the values realm
   - Differences (or congruence) in goals
   - Differences (or congruence) with user in perceptions of, need for and value of a given innovation (in the light of available user resources)
   - Differences (or congruence) in orientations and perspectives (e.g.: relative to pragmatism, time horizon, local/cosmopolitan)
2. Entrepreneur/user interaction in the knowledge/skills realm
   - Skills for need identification, search, implementation, and utilization
   - Relativeness to the nature of the knowledge base (e.g.; scientific vs. craft, level of certainty)
3. Environment context of resources and support
   - Availability or limitations (e.g.: amounts, stability, etc.) of funding, personnel, information
   - Sponsorship and constraints
   - Ability to mobilize resources
   - Conflict/cooperation (e.g.: available coalitions for implementation)

4. Structural context of entrepreneur/user relations.
   Linking roles
   Nature of boundaries and organizational configuration
   Institutional size

From this analysis, we can see that our focus is now upon:

1. interaction between entrepreneur/user attributes in the value and skills realm; and
2. the resource/support and structural contexts of entrepreneur/user interaction.

In Matrix 8, we engaged in an exploration of many of the contextual factors that might be expected to be of importance in an analysis of entrepreneur attributes. The above discussion has acted both to capture some (but not all) of the richness of the analysis and to permit us to focus in on a more limited number of policy relevent contextual issue areas. These issue areas may lead us to make determinations about:

1. when and where entrepreneurial activity might be desirable (taking into account goal and value differences between potential entrepreneurs and potential innovation users;
2. skills that are needed (taking into account the entrepreneur/user skill fit);
3. requirements (in the areas of resources and support);
4. institutional and structural characteristics.

5. Interactive Analysis of Key Factors and Entrepreneur Characteristics

The concerns we have just listed would provide the outline for a number of analyses relevant to a series of policy options and programs. However, for the purpose of providing a single illustrative analysis here, we must yet take two more steps: one to further narrow our focus and one to add an extra dimension to our analysis.

MATRIX 4:

ANALYSIS OF SEVERAL ENTREPRENEUR ATTRIBUTES AS DETERMINED BY SELECTED CONTEXTUAL DIMENSIONS

Selected Dimensions of Contextual Conditions	Entrepreneur Attributes			
	Orientations/ Perspectives	Legitimacy	Location	Skills
1. User Attributes 1.1 Values a) Goals-perceptions of value of innovation b) Orientations/ perspectives				
1.2 Knowledge/Skills a) Skills for: -Implementation/ utilization -Need identification and search for the innovation* b) Knowledge base relation				
2. Resource Support Context a) Resources b) Support: -Sponsorship -Conflict/ cooperation				
3. Structural Context a) Linkage roles b) Boundaries c) Configuration d) Size				

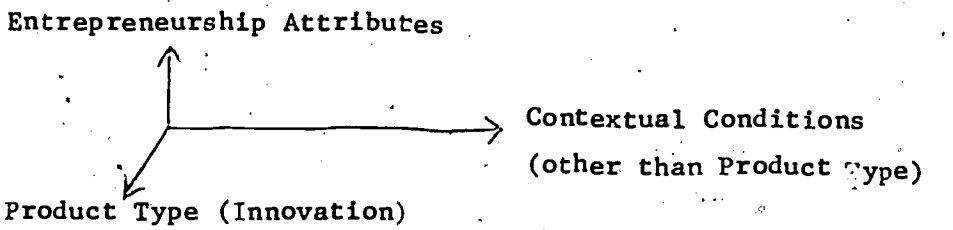
*This implies the skills of knowing what is needed and how and where the need can be satisfied.

Matrix 4 would provide the framework for an interactive analysis of the key factors and entrepreneur characteristics to which we have thus far narrowed our focus from the original larger set of contextual conditions (which we have postulated as being generic to all R/D&I systems).

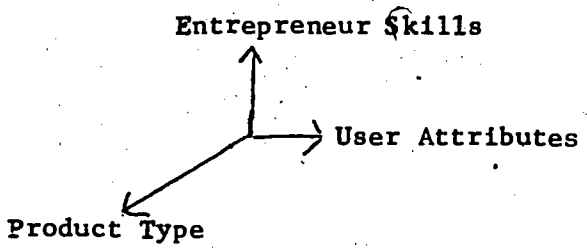
A complete analysis of the issues implicit in Matrix 4 would be very desirable and enlightening, but beyond the scope of our present illustrative effort. Matrix 4 unquestionably contains a sufficient domain for a substantial dissertation. We have therefore, refrained from attempting to fill in the cells of the whole matrix but rather will concentrate now on that smaller portion that has been shaded in the matrix. This represents the interaction between entrepreneur skills and user attributes, but with special emphasis on the skills areas (as being potentially specially susceptible to policy initiatives).

6. Product Type as a Dimension for Interactive Analysis

In addition to the above entrepreneur and user variables, there is one other aspect that we have not yet considered: the substantive content of the innovation that is the subject of the entrepreneur's activities. In the interaction between the entrepreneur and the user, the nature of the product (or innovation) is a potentially critical parameter for the analysis. In this specific case it would, for example, make a great difference if the entrepreneur was promoting a new innovation or a more matured product; whether the product was simple to use and its benefits relatively self evident, or a difficult to use product of uncertain benefit. Thus the innovation (our R/D&I feature 19) in this case is a key factor in this analysis. At a general level of analysis, we might conceptualize the interaction as follows:



More specific to our purposes here, the interaction would be:



II. ENTREPRENEUR VS. USER INITIATIVE IN NEW PRODUCT DEVELOPMENT: AN ILLUSTRATIVE POLICY ANALYSIS OF THE ENTREPRENEURSHIP ISSUE

We have now reached the point where it becomes feasible to undertake detailed theoretical but policy-directed analyses. We have thus achieved our stated objective of following a reductionist methodology (i.e., narrowing our focus to a manageable level), while at the same time pulling with us those critical contextual conditions that will provide a rich level of analysis -- thereby permitting us to deal with a focused (and therefore policy and management actionable) issue in the larger frame of reference.

Further, we have followed a procedure that would enable us to trace back any implications into the total, holistic framework. This has been indicative of a deductive approach. It is important to emphasize that in practice the selection of an issue area (or areas) might be arrived at inductively. The primary purpose for [redacted] matrix analyses in such cases is to fit the analysis into a comprehensive framework and relate it to its relevant context features and to other issues. Also, it should be noted that the general guideline for determining when sufficient detail has been achieved is a pragmatic one -- i.e., as detailed as is useful to identify and/or deal with specific issues of policy and management concern.

1. The Illustrative Policy Issue: Entrepreneur vs. User Initiative in New Product Development

Let us now proceed by analyzing a significant policy issue that involves

the consequences of entrepreneural behavior in the innovation area.

Considerable interest has been recently focused in studies of R&D and innovation on whether the entrepreneurial initiative for new product development and introduction derives from the initiatives of producers or from the initiatives of users (see for example the work of Radnor and Neal,[6] Von Hippel[10] and Abernathy[1]). Thus, in the technical instrumentation case Von Hippel has identified the users (customers) as the prime stimulus source. In contrast, Radnor found the producer to be the prime mover in certain law enforcement equipment cases, with randomness almost seeming to be the most reasonable description of the process in most other law enforcement equipment cases. Abernathy has commented on the fact as a product area matures (as in the case of automatic machine tools), there may be a shift from user to producer (supplier). Many examples can be cited from the health field of fully cooperative ventures between producers and users (e.g.: Schermerhorn[9]). Of course, we must allow for the possibility of external imposition of innovations.

2. A Typology of Entrepreneur/User Relations

From the few examples noted above, it seems possible to construct a typology of producer (entrepreneur)/user relationships in terms of innovative initiative. Since we are focusing our analysis on the producer as the entrepreneur, the typology in Figure 1 below (and subsequent discussion) will use the term "entrepreneur" to refer solely to producers.

1. Entrepreneur dominated
2. User dominated
3. Cooperative (entrepreneur/user)
4. Externally imposed
5. Serendipitous

Figure 1

Typology of Entrepreneur/User Initiative in Innovation

Given a policy objective to intervene and manage the innovation process, knowledge of the conditions that might lead to and influence these processes would be vital. We are now in a position to connect our analysis thus far to this issue area of innovation initiative in a demonstration of our inductive/deductive process.

From Matrix 4 and our earlier typology of product dimensions, we may see our analysis as involving:

User Attributes

- Implementation/utilization skills
- Need identification and search skills
- Perceptions of the value of the innovation with respect to resources

Product Characteristics*

- Maturity of the product
- Complexity of the product with respect to user knowledge base**

Entrepreneur Skills

- Need identification
- Developmental
- Marketing
- Consulting/service

3. Illustrative Analysis of Outcome under Varying User/Product/Entrepreneur Conditions

The above scheme can be illustrated by selecting several varying sets of conditions (cases) drawing the partial implications that could contribute to a total study.*** The seven cases we have chosen for analysis are summarized in Figure 2. These seven cases illustrate some of the likely outcomes that can be expected under varying user/product/entrepreneur conditions.

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*Only two dimensions have been selected to simplify the analysis - as relevant others would be required.

** Product complexity here implies complexity in acquisition, implementation, utilization, maintenance, etc. Thus it captures the issue of the nature of the knowledge base that provides the criterion for relative user/entrepreneur skills.

***It is important to keep in mind that the analyses and later derived policy implications are only partial and contributory to a total analysis in that they are limited to the sub-set of variables we have chosen to examine.

Conditions	Case A	B	C	D	E	F	G
User							
Need ID and search skills	Low	Low	High	Low	High	Medium	Low
Implement/utilization skills	Low	Low	High	Low	High	Medium	Low
Perceived value of innovation	High	High	High	Variable	High	High	High
Product							
Maturity	Low	Low	Low	Low	High	[illegible]	High
Complexity	High	High	High	High	High	[illegible]	Low
Entrepreneur							
Need identification skills	High	High	Low	Low	High	Medium	High
Developmental	High	High	Varia	Variable	High	Medium	High
Marketing skills	High	High	Vari	High	High	High	High
Consulting/service skills	Low	High	Vari	Low	High	High	Low
Consequences							
Innovation domination	Entrepreneur	Entrepreneur	User	Variable (Serendipitous)	Entrepreneur in large market, otherwise cooperative	Cooperative	Cooperative or entrepreneur for diffused users
Entrepreneur opportunities	High user receptivity to product	High user receptivity to product & service	Receptive user with well defined (designed) product (innov) needs	Naive user	Receptive user with well defined needs	Receptive user with well defined needs able to accept help on implementation	High user receptivity to product
Problems encountered	Low success with implementation & utilization. High dependence on entrepreneur for innovation proposals. Leads to frustration	High dependence on entrepreneur for both innovation proposals & for implementation. Can lead to captive relations (Monopoly)	Technology transfer to other potential uses. Size & generality of markets	Low probability of finding fit, attempts to implement inappropriate innovations Highly responsive to external pressures.	Markets can become very competitive. "Not invented here"	May limit technology transfer to other uses. Entrepreneur need identification skills may not develop	Entrepreneur may sell user on innappropriate products. Market may become very competitive

Figure 2: Comparative User/Entrepreneur/Product Cases

A. The Cases

i. Case A

In Case A we have an entrepreneur with well developed need identification, developmental and marketing skills in relation to the nature of the product, a new and complex one. The entrepreneur understands the user's problems, knows what products are needed, and can deliver them. He also knows how to reach and make the sale to the customer -- but can do little to assist in the implementation and on-going utilization problems of a user who is weak in these same areas and therefore needs the unavailable help. Additionally, the user lacks the competence to be able to identify (or to differentiate between) what and whose products might (or might not) solve his problem -- but sees a high value in any innovation that could help.

As a consequence it is the entrepreneur who dominates the innovation process. He takes the initiative both as to determining the characteristics of the innovative product and as to providing the linkage with the user. In this, an important service is provided to a relatively helpless user -- a user who (because of the great perceived value of the innovation) is found to be highly receptive to the entrepreneur's initiative and product. Unfortunately, that is where matters come to a halt. With a complex product (and given both the user's and the entrepreneur's lack of implementation/utilization skills) we are likely to encounter failures at this stage of the innovation process.* Another continuing problem is that the user continues to be highly dependent on the entrepreneur for future innovations in the same area. The inevitable long-term result is great frustration.

The above is a very familiar scenario. It is interesting that case A does

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*For the sake of illustrative simplicity we are restricting these cases to two party situations. In the complex real world there are often more than two key parties to a relationship, e.g.: in this case a partial compensation could come from the existence of competent consultants.

well represent our observations of the two-way radio market for police departments in the case of the unsuccessful (or very much less successful) producers.(4)

ii. Case B

Case B, however, represents the condition for the extremely successful entrepreneur in the same market -- one that has come to capture the bulk of the business in the field. And yet, interestingly, the two profiles for A and B show only one point of departure. In Case B, the entrepreneur has strong (high) consulting/service skills, as compared to C.* (low) skills in Case A.*

As in Case A, the entrepreneur is the dominant innovator to a receptive user market -- but this receptivity extends to the service as well as the product area. The entrepreneur now is capable of providing the vitally needed help in implementation and utilization -- possibly setting up technical service functions in an equivalent of an "extension service". As a consequence, success rather than failure attends these efforts; and instead of frustration, we observe a growing productive interdependence. Other users, frustrated by their experiences elsewhere, [illegible] the relation, even though they might not [illegible] to be [illegible] by the growing giant. [illegible] they are. The very "success" of this relationship illustrates [illegible] problems. Captive users may become resentful of the increasingly powerful entrepreneur, who sees no incentive to help upgrade the skills of dependent customers. This can lead to resistance and may reduce the great service provided in the field situation upon which the success is founded.

iii. Case C

The same type of product (new and sophisticated) is found in Case C,

*This is not to imply that there may not be other important differences beyond this analysis framework.

but this time it is the user that posesses the critical need identification, search and implementation/utilization skills rather than the entrepreneur. Nothing moves until the user: (a) recognizes a need for a specific innovation precisely defined (sometimes even designed) by itself; and (b) initiates a relation with potential producers (possibly in the form of a request for a bid to produce a specified product). Even though the entrepreneur's marketing skills may be valuable in helping to land the contract, it will be the user that will dominate the innovation relation. The entrepreneur's task is made easier, but his ability to make a technological transfer of the innovation to other applications may be limited both by his own possible lack of skills in development and/or need identification and by the control that the user may exert over products of its own initiation and design. Thus, the entrepreneur may be limited in expanding the market size beyond the original user, and the limited market acts as a further constraint on innovation. This is often the situation where highly sophisticated users (e.g.: the large automotive companies or high technology federal agencies) contract out to machinery or instrument makers for a highly specified new product.

iv. Case D

In Case D, we once again find a naive user faced with a new and complex innovation, as in Cases A and B. In some respects, the user is in an even worse condition because he is less clear about the value of the innovation. However, in Case D, the entrepreneur (unlike Cases A and B) cannot compensate for the user's need identification weakness -- he too, is ill-informed on which users need what. Even his developmental skills are suspect; and he can give little implementation and utilization assistance. Under these conditions it would be surprising that users and entrepreneurs manage to find a proper fit. That this does occur of occasion is best ascribed to serendipity.(7)

A problem of significant magnitude is that the considerable marketing

skills of the entrepreneur in Case D can lead to users acquiring inappropriate innovations (gadgets and fads) that may squander scarce resources. Outside pressures (for example, from political and lay sources) may be difficult to resist because the user lacks justifiable alternative programs. The world of education and many areas of local government seem to fit this context in various product areas.

v. Case E

Case E mirrors Case C in terms of product and user characteristics -- except that we now observe a mature rather than a new product situation. The difference is significant. The entrepreneurs have had time to learn the business in all its aspects and to become appropriately adapted. This permits them to assume the dominance of the innovation environment and allows them to entrepreneur in wider market. This is a commonly observed phenomenon, as is the case where a machine builder is able to develop a general purpose (as opposed to a specialized) product that can serve a variety of applications areas. Under large market conditions, problems of over-competitiveness can develop. Many entrepreneurs can learn the business and the high profit of a large market is a major attraction. In some other cases, the constraints of the original application area or the original innovation limit such generalization. In those cases, the entrepreneur lacks incentive and the relation tends towards one of limited entrepreneur/user cooperation.

Another potential problem may arise precisely because of the sophistication of the users. To them, nothing produced on the outside truly measures up to their perceived needs, or the quality of the product they could produce themselves (but for the constraints of time and cost). This often surfaces in the "not-invented-here" syndrome, with users feeling obligated to rework products that are acquired: cosset up idyosyncratic specifications demanding high priced "specials" as opposed to off-the-shelf standard products; and so on.

vi. Case F

Cases F and B are more alike than they appear at first glance on paper. The overall level of available skills between entrepreneur and user are not greatly different, but they are significantly different in distribution in two areas: need identification and implementation/utilization.

In relation to need identification under Case F conditions, the user and entrepreneur find their fit because each has some degree of capability to seek out the other in an area in which innovation is needed and not generally well understood. (A high/high combination for need identification would also have this result, but would generate a greater level of potential independence of the parties than occurs in Case F, where a fit is established.) The parties in Case F need each other because they each have some difficulty in identifying appropriate alternatives. This may be true even when the relationship is less than optimal (e.g.: there may be more competent entrepreneurs around, but a switch may be seen as difficult and/or risky by the user).

Additionally, the user needs some implementation/utilization help -- which the entrepreneur is in a position to provide -- but has a sufficient level of in-house competence to be able to accept help in a productive manner. A cooperative relationship is the obvious consequence. The very comfortableness of the relation may, however, act to constrain technology transfer to other applications and may reduce the incentive for the entrepreneur to sharpen its need identification skills. Long term consulting relationships often have these qualities.

vii. Case G

The final Case (G), unlike the others, involves a mature product of

low complexity, but with users and entrepreneurs having the same characteristics as in our first Case (A). In this instance, the simplicity of the product and the long user and entrepreneur experience both facilitate the selection and implementation problems. The technically weakest user can adapt to the product requirements; the relationship becomes more cooperative; and the entrepreneur's domination lessens. This does not guarantee that the user is adopting the proper products, only those to which he has become accustomed. The form of the "cooperativeness" could be a combination of market research (what does the user want) and persuasion (marketing/advertising). The simplicity of the product may invite competition from small, sometimes low skill entrepreneurs (alley shops) -- unless scale considerations prevent this. In the high volume, mass user cases (consumer industries), the entrepreneur maintains domination due to the diffuseness of the user population.

B. Maturation and the Dynamic Nature of the Innovation Process

Case G and the previous Case E are important in our analysis in another respect. Both represent cases of mature rather than new innovations. As such they depart from our original perspective for this whole analysis, namely that we are exploring the entrepreneur/user relation in the early developmental phase of an R/D&I situation. The comparison of Cases A and G emphasizes the importance of the time dependent maturation process. The learning and mutual adaptation that go on lead to modified outcomes. Even the difference in product complexity between cases A and G could be interpreted, at least in part, as being a shift in perception resulting from learning and adaptation. While it is not necessarily so, one way of looking at Case G is as a more developed or matured form of Case A, with some (though not all) of the problems having become ameliorated. This recognition must reinforce our understanding that the innovation process must be examined as a dynamic phenomenum in which the changing role of the entrepreneur in relation to the user may be of critical importance.

4. A Cross-Sectoral Comparative Case Analysis of OR/MS as an Innovation

A. Some Further Considerations

1. A Contributory Illustrative Analysis

Before going on it is important to keep one point in mind. Entrepreneurship was selected for illustrative purposes out of a larger set of issues. The matching of entrepreneur skills with those of the users was similarly selected. Our purpose has been to illustrate the insight and explanatory power that can be derived from our analytical procedure. It has not pretended to completeness, but rather to being contributory (perhaps importantly) to a total system analysis.

2. The Complexity of Skill Level Variations

Before we leave the analysis of these cases to go on to consider the policy options and management strategies available to deal with the emergent problems, some enrichment of the analysis would be helpful. For simplicity we have categorized users and entrepreneurs as being high, medium or low in any given skill area. In practice it is not quite that simple. A user may have generally high implementation skills, for example, but lack experience in a specific applications area. Such a user is not in the same condition as a user who lacks such skills in all areas, including that of the specific application.

3. Behavioral Consequences of Differences in the Skills Balance

We have also not given full recognition to some of the behavioral consequences of the differences in skills balance. Thus while high entrepreneur to low user implementation skills can be seen by the user as helpful, the balance could (

also lead to resentment, mistrust and resistance. In turn low entrepreneur skills could lead to lack of legitimacy in the eyes of a highly skilled user (although we did not have such a case among the seven presented in relation to the implementation/utilization skill area).

B. The Adoption of New Management Technology: OR/MS

The specific case involves the adoption of new management technologies in the 1960's to early 1970's -- specifically, operations research/management science (OR/MS and associated methods). This case is taken from empirical observation. In this case the issues just noted above will appear -- as will the dynamic nature of the innovation process which we noted earlier. The case is also interesting in that it deals with an example of entrepreneuring a software (systems or service) application as opposed to a hardware product, within institutions (i.e.: through internal entrepreneurship). The case is given across three sectors: industry, law enforcement and aerospace.

C. Comparative User/Product/Entrepreneur Conditions Across Sectors

In the three sectors, the comparative user/product/entrepreneur conditions relevant to the introduction of OR/MS as an innovation would be approximately as in Figure 3 (using the categories in Figure 3). It should be kept in mind that the empirical studies found considerable variation across institutions in each of the three sectors. Thus, we recognize that there may be a potential for variability from these ratings in any category.

User	Industry	Law Enforcement	Aerospace
Need ID/Search	Medium	Low	Medium
Implementation/Utilization	Medium	Low	High
Perceived Value	Low	Low	High
Product			
Maturity	Low	Low	Low
Complexity	High	High	High
Entrepreneur			
Need ID	Low	Low	Medium
Development (Technology)	High	Medium	High
Marketing	Low	Low	Low
Consulting/Service	Medium	Low	High

Figure

Comparative User/Product/Entrepreneur Conditions
Across the Industry, Law Enforcement and Aerospace Sectors

D. A Sectoral Comparison

1. Industry

In big industry, the entrepreneurs of OR/MS methods were (by and large) highly skilled practitioners of OR/MS technologies, were weak in their understanding of user problems, poor in marketing competence, and at best fair in their ability to assist in implementation.(5) In contrast, their clients -- the ultimate users -- were relatively unfamiliar with OR/MS methods, although many of them had considerable knowledge and experience with alternate techniques and approaches to solving the problems involved. They could, fairly quickly, develop an appreciation of application methods, expected outcomes, and (importantly) see the weaknesses of new techniques vis a vis their needs. Initially, users (often with the support of other competitive high skill professional groups -- e.g.: accountants) tended to react more to their perceptions of these weaknesses than to recognize potential OR/MS benefits. The result was an initial clash between the OR/MS entrepreneurs -- followed by an intensive (and generally successful) period of mutual education of users to OR/MS and of OR/MS entrepreneurs to user needs. This led eventually to widespread and relatively successful adoption of OR/MS in the larger industrial firms, with the technologies coming to diffuse widely within these firms.

2. Law Enforcement

In the case of law enforcement, the internal entrepreneurs of OR/MS were themselves, in general, also not very skilled in their technologies. Their clients were even less skilled than their industrial counterparts in either the OR/MS or equivalent techniques. As a result the OR/MS "revolution" hardly got off the ground, and it took the infusion of skilled external

consultants in a major role before noticeable progress was to be observed. Until the skill level of the entrepreneurs was upgraded in this way, little in the way of transactions was to be effected in this even more extreme example of Case D above.

3. Aerospace

In a case crossing industry/government lines (aerospace), both OR/MS entrepreneurs and clients were technically very skilled. As a result there tended to be a high level of initial agreement and a limited set of applications were implemented in mutually agreed areas. However extension of OR/MS to other problem areas was limited to continued acceptance and utilization in the early agreed areas, somewhat like the result of the previous Case F situation.

E. Implications

From these cases we might observe that a small entrepreneur-to-user skill gap can have very different results, depending on whether this occurs at mutually low skill levels (as in the law enforcement case) or with mutually high skills (as in the aerospace case). Further, where the entrepreneur has a large skill increment over his clients (as in the general industry case), if the clients start at a high enough level the potential may be excellent for adoption and diffusion, even though there may be considerable initial problems to be overcome -- the clientele is essentially educable as long as the entrepreneurs are flexible enough to mutually adapt to educated user needs.

5. Illustrative Analysis of Policy/Management Options Under Varying User/Product/Entrepreneur Conditions

The earlier analysis of seven case situations (Cases A - G) generated a number of policy/management relevant issues within each case situation. This analysis can be pursued further to illustrate some possible policy and management strategies available to the various parties in the R/D&I system. Figure 4 illustrates some of these potential actions which could be taken by the users, the entrepreneurs (producers) and by super-ordinate (general level) policy makers (e.g.: top management in an organization or, in the macro case, a federal agency). This figure shows in each case the results that might be expected if the potential option or strategy is exercised.

i. Case A

The problem in Case A was of a low skilled user dominated by an entrepreneur who was unable to assist in the implementation/utilization of an innovative and complex product (and implicitly assuming the unavailability or of third party; e.g.: assistance from consultants).

The user's strategies fall into two general but interactive categories: (1) upgrading its own skills and (2) switching producers/entrepreneurs, if this latter option is feasible.

By improving need identification and search capabilities (which might be done directly or in fact through some form of contracting out as with consultants), the user would be better able to know what products are needed and where to obtain them, thereby creating greater user freedom viz a viz potential entrepreneurs. Improving implementation/utilization skills could increase the success of the innovation activity and again supplements the user's independence. In turn this independence and the associated improved need identification and search

Figure 12 Comparative Cases: Policy Options and Expected Results

Case	A	B	C	D	E	F	G
User options & Strategies	Improve directly or thru consultants 1. Need ID 2. Impl/util skills Switch to more skilled producer	As in A	Help educate producers in need ID development, service skills	Improve all skills. Increase contacts with more competent users	Engage in personnel exchange programs with other users & producers. Programs to keep close to state of art	Improve need ID & implementation skills	Improve need ID skills
Expected Results	1. More user initiative 2. Improved Impl/util success	As in A	Reduced burden on self. Opens up added sources of innovation. Reduced costs thru larger markets	As in A plus better understanding of application benefits & costs	Reduced provincialism. Avoids creeping obsolescence	Widened range of potential suppliers and applications increased competition among producers	Acquisition of more relevent products and processes. Learns to avoid fads
Entrepeneur options & strategies	Improve consulting/ service skills	If user seeks help can become source of user training as above	Improve skills in all areas. Learn from users	Improve need ID, developmental & consulting/ service skills	Maintain active R/D & a program to stay with or ahead of users	Improve need ID and developmental skills. Aid user to develop skills	Improve consulting/ service skills
Expected Results	Improved implementation success	Wins user's loyalty and help overcome resistance	Increased role in relationship. Opens up new applications (market) outlets	More focussed marketing efforts with more appropriate products. Wins loyal users (customers)	Maintained position	Widened range of outlets for products and services. Wins loyalty of user	Helps lead user into more sophisticated & less competitive products

Figure 4 Comparative Cases: Policy Options and Expected Results

Case	A	B	C	D	E	F	G
Super-ordinate Policy Maker Options	Support training & recruiting programs for users in need ID, & implement/utilize. Help set up consulting & extension services & information systems if unavailable	As in A	Provide incentives for R/D & I programs at selected producers. Create information diffusion (T-U) systems.	Support training programs for users & producers (including joint programs). Help establish information diffusion, standards setting & consulting mechanisms	Encourage interchange programs Encourage producers to enter related fields (markets)	Information diffusion programs to promote technology transfer	Aid establishment of standards & consulting mechanisms Assist user skill development programs
Expected Results	More user initiative. Improved implementation	As in A plus helps wean away users from dominant producer	Wider innovation base. Greater diffusion of innovations.	Higher rates of proper & well diffusion used & implemented innovations. Less fads, more defensible programs	Helps prevent stagnation from complacency & provincialism. Expends capabilities into related areas	Broadened base of innovative activity.	Upgraded quality and relevence of applications

Figure 4 (cont.)

skills makes it feasible for the user to switch to an entrepreneur (if such an alternative is available) that can better supply its needs, with similar consequences for success. If the switch takes place without the prior improvement of user skills, then the danger of becoming captive (as in case B) arises.

The strategies for upgrading in-house user skills would usually involve some combination of training and recruitment of new personnel and contracting out as noted. A partially similar result can be obtained through improving the flow of product and process information on availability, applications and performance evaluation. This is not usually within the power of the user to influence externally. The user can, however, attempt to insure utilization of information which is available (although unfortunately most such users that need the help cannot differentiate between poor and good quality information). Informal relations with other trusted and more competent users is frequently another source of need identification and search information, and properly exploited this strategy can be of great assistance.

The entrepreneur can attempt to upgrade the service and consulting provided by it to users. This would have great benefits to the user making it less necessary to either build individual skills or look elsewhere (although the former response has the already-mentioned problems of leading to user captivity). Depending on the situation this could be a difficult, costly and slow-to-achieve strategy (e.g.: it might require the setting up of a national field service network). In the intra-organizational case it may call for a change of style of operation and the number and type of personnel -- a possibly more feasible if sometimes uncomfortable (and hence resisted) option.

A top level policy group or a government agency attempting to intervene in the case A context should be aware of the leverage opportuni-

ties that exist in supporting users in their attempts to upgrade themselves through training and recruiting efforts.. Other policy options might lie in supporting the emergence or development of departmental, local or regional information services. A special sub-issue involved in improving the quality of information flow to users which lack necessary need identification skills is the creation of some form of product standards, thereby simplifying the user's decision problems. The creation of improved information seryices and standards programs are, as we noted above, outside the sphere of influence of most users, but is a most appropriate policy option at the governmental level and even at the organizational level for large institutions.

Support could also be provided to entrepreneurs attempting to build up their skills. Within institutions this may not be a major problem, but at the macro level, governments may be constrained in supporting one producer over another in terms of the effects on competition. Even so, ample opportunities may be available. These could involve the support of model programs designed to assist users on implementation problems, etc., with obvious self training and system spin-off effects. These opportunities could also involve the promotion of joint ventures; e.g.: between organizations with strong development skills but poorer service capabilities and other organizations having complementary strengths and weaknesses (e.g.: insisting that large prime contractors subcontract out implementation and service roles to smaller regional institutions that may survive only because of their strengths in their specific areas). Even the strengthening of a single entrepreneur with the needed skills could act as an incentive to the others to make similar improvements if they are to prevent erosion of their position with clients and customers as these gravitate towards the unit providing the better service.

We must also not lose sight of the fact that, as we noted earlier,

We are dealing with a dynamic phenomenon with time-dependent characteristics; i.e., we are looking at an issue that involves an historical developmental process of innovation. To an important degree the problems we are discussing exist because of the emergent and developmental character of the R/D&I process. With sufficient time and a low rate of new introductions of innovation, considerable learning and adaptation can and usually does take place -- although some (or much) of this can be maladaptive and dysfunctional.

Hence one policy option is to do nothing. Over time, even without much help, users will tend to work out a tolerable degree of implementation and utilization (or else disappear) -- and many will gravitate to those entrepreneur/producers that can provide the needed help. Entrepreneurs will gradually learn about the problems of a limited user group, and become more helpful. Depending on how critical the problems are, what other priorities exist, and the feasibility and cost of alternative action strategies, the decision will have to be made to deal with identified problems or neglect them -- with these considerations applying to users, producers and higher level policy makers.

We recognized this earlier when we noted that case G could be considered as synonomous with case A but in a matured form. The differences in context and outcome could be ascribed to the effects of learning and adaptation over time. This strategy (if we can call it that) does lead to solution of some of the implementation/utilization problems; and more cooperation between producers (former entrepreneurs) and users tends to develop, even though some of the basic structural weaknesses remain (possibly to haunt us -- we still see users making inappropriate product acquisition decisions). Case B can also be viewed as a development of A over time. If the outcomes in A are sufficiently frustrating, then some users will also find their way over to a Case B context prior to any real learning and adaptation (if this is feasible -- there may of

course not be an entrepreneur with case B characteristics available in any given context). As earlier indicated, to the extent that this can and does occur, it will create an incentive to other entrepreneurs to upgrade their own skills to counteract such a trend, although as we noted this may not always be feasible.

The discussion of policy options and strategies for case A above is based on a perspective that is very different from the one which can be observed in the making of much of current federal government R/D&I policy. Here we typically encounter the situation where an observation is made that a particular context has shown a history of lack of successful innovation. Whether this has been due to an insufficient flow of innovations or a record of poor implementation on the part of users is often less clear. That both of these problems may be derivatives of poor interaction between producer/user skills relative to the novelty and complexity of the applications is almost never considered.

Instead the problems tend to be defined as the result of:

1. a lack of incentive on the part of producers to innovate (to be solved by creating more competition; by subsidizing innovation activity: e.g., by the special purchase of innovative products by government in the hope that this will lead to more general application and diffusion -- as in the ETIP program of the National Bureau of Standards);
2. a lack of capability of producers to innovate (to be solved by having government doing it for them and through various programs of technology transfer and utilization -- e.g.: Technical Utilization programs)
3. a lack of incentive by users to adopt innovation (provide subsidies);
4. an inability to innovate due to lack of resources, information and skills (provide subsidies, pre-packaged programs and model programs);

5. a resistance to adopting innovation (to be overcome by various types of enforcement and sanction processes, inspirational treatments, and behavior influencing and modification programs: e.g., use of participation and feedback etc.).

This is not to say that the above analysis of problems are necessarily wrong or the proposed solutions useless. To the contrary, it is our position that a complete analysis of a situation looking at issues of funding, incentives, capabilities, information flow, problems of implementation/utilization, etc. (as would be the product of a complete study using each of the dimensions of our analytical framework) would turn up the same issues as above, and many more. Rather it is to reinforce our position that only through such a total R/D&I system analysis can one hope to reach into the real causal factors and develop appropriately balanced policy options and management strategies.

It is therefore the objective of our present illustrative analysis and policy derivation effort to demonstrate that there may be critical perspectives that can contribute to the explanation and solution of frequently experienced problem situations -- and that these critical perspectives that tend to be missed without the type of systems perspective and contextual analysis we have been illustrating. It is in this light that the above discussion of entrepreneur/user skills interaction has been presented as a partial contribution to the analysis and solution of outcomes in the innovation process. In the complete analysis the findings and recommendations above would have to be weighed against and combined with alternative and complementary explanations and strategies.

ii. Case B

Case B, as described in Figures 2 and 4 , is in most ways the same

as Case A -- and most of the previous discussion of Case A need not be repeated here. However, there is one basic difference. In Case B, the entrepreneur is already skilled in the service/consulting skills which are lacking in Case A.

In one sense, no action is called for in Case B. The situation is already favorable to the entrepreneur -- so he will not want to "rock the boat". However, the "monopoly power" position of the entrepreneur leads to user dependence and thus to user resentment and even potential resistance. The alert entrepreneur might thus, within a broader and longer time horizon, attempt to assume the role of helping the user improve its own skills -- thus moving away from a "monopoly power" based relationship. The entrepreneur is even more likely to assume this role where there are signs that users are becoming receptive to such help and/or where other sources (e.g.: the federal government) are initiating programs to make such help available.

iii. Case C

Case C involves a highly knowledgeable user controlling the innovation relationship for a novel and complex product with an entrepreneur with weak need identification skills. The problem here was centered in the limited domain of the innovation base with limited technology transfer to other applications and wider markets. Under some conditions this would be ideal for the user who preferred to be the sole beneficiary of a particular technology. However, the cost might be higher prices for the very specialized product, in monetary and/or personnel effort terms. Thus, to lower costs, a user strategy would be to work with the entrepreneur to make it possible for the entrepreneur to take on the developmental burdens (from the user); to supplement its own innovative efforts with those of the entrepreneur; and to increase the entrepreneur's efforts to reach a wider user group -- hence creating a larger

domain for the entrepreneur and potentially lower costs to the user.

The entrepreneur could (if it saw the wider opportunity) seek to upgrade its skills, including learning from the users (possibly by putting in more than the minimum manpower effort to satisfy the contract). This should result in a gradual shift in the balance of the relationship, particularly if a wider market were emerging which would permit the entrepreneur to invest in relevent competence at a much higher rate.

Super-ordinate level policy makers, especially at the governmental level, could seek to build up entrepreneur competence by providing incentives to develop R/D&I programs and assist in the creation of information diffusion (technology utilization) programs. This could help widen the innovation base and stimulate greater diffusion of the innovations generated by the user.

iv. Case D.

Serendipity was our description of Case D. Naive users were being served by entrepreneurs whose only clear competence was in marketing in a complex and innovative applications aread. Clearly there are major benefits to be derived by both users and entrepreneurs in generally upgrading their skills, leading to a better fit between user needs and products and services provided. Users might make special efforts to be in contact with other more competent users, thereby gaining the benefits of their experience with sources and products. With such relatively helpless users, the entrepreneur which does build up its abilities to provide relevent and needed services can hope to win the long term loyalty (and even dependence) of users - in fact converting to a case B type situation.

Support for training programs for users and entrepreneurs (including possible joint programs) could be a useful strategy for super-

ordinate level policy makers. Other options would include the setting up on information diffusion systems (newsletters, magazines, STI systems, etc.), the establishment of standards programs and systems to create common product and performance criteria, and (potentially very important) the creation of consulting and service organizations and groups available to both entrepreneurs and users. One of the indirect benefits of such efforts might be to make innovation programs more defensible and less subject to pressures from outside groups (stockholders, the citizenry, etc.).

v. Case E

Case E can be looked at as the end product of the various policy and management programs and the effects of maturation. All skills are high, the product is matured, although in this case (unlike G) still seen as complex. However, as there are no perfect solutions in organizations, the key problem is that of a potential insularity and provincialism that could develop with the Non-Invented-Here syndrome. Each group believes itself too skilled to need the other's help. The objective of policy programs, especially from the perspective of users and super-ordinate level policy makers, would be to encourage personnel and information interchanges to combat these potential problems. Government policy makers and top managers might be especially anxious to diffuse the benefits of the available skills to other areas, again through the interchange and technology transfer mechanisms. From the perspective of the entrepreneur, it is vital to maintain an active R/D&I program to stay with or ahead of users and so maintain position. There are other strategies between such entrepreneurs (such as collusion) that might help them, but these are not usually accpetable (or even illegal in the U.S.).

vi. Case F

The cooperative situation in Case F is comfortable but limiting. Users and entrepreneurs need each other due to their mutual short-

comings but are not necessarily performing at an optimal level. The improvement in need identification, search and developmental skills (as appropriate) can lead the user to wider and possibly better options -- and possibly at the same time stimulate competition and (for the entrepreneur) open up wider opportunities. To the extent that the entrepreneur can assist the user in skill development, this may help to generate future user loyalty. The policy requirements at the super-ordinate role are to help broaden the bases of the innovative activity for both users and entrepreneurs through supporting or creating information diffusion and technology transfer programs.

vii. Case G.

Case G represents a potentially matured condition of case A, as we earlier noted. The user's needs now are to grow beyond its present limited perspectives that make it susceptible to the acquisition of gimmicks and fads through development of its discrimination (need identification) skills. Improved implementation skills would add to its independence. These thoughts would be very appropriate whether we were discussing institutional or mass consumer users (the purpose of much of the present consumer education efforts). From the point of view of the entrepreneur, improving service skills could enable the entrepreneur to lead users into more complex applications and products -- and thus out of the matured, low complexity product areas which are likely to be highly competitive. The role of top level policy makers, especially government, would be to upgrade the quality and relevence of applications by assisting users to upgrade their skills, by the creation of consulting and service organizations (e.g.: Consumer advice bureaus), and by the creation of product and service standards (e.g.: Underwriters Laboratories, Consumer Reports, Product and Performance Standards in industry, health, food etc.).

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CHAPTER TEN

IMPLEMENTATION AND UTILIZATION:

STRUCTURAL ATTRIBUTES OF USER ORGANIZATIONS

Major contributions to this chapter were provided by Atul Wad and Earl C. Young.

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IMPLEMENTATION AND UTILIZATION:
Structural Attributes of User Organizations

I. INTRODUCTION

The focus of this illustrative contextual analysis is on the implementation and utilization (I/U) feature of the total Research, Development and Innovation (R/D&I) context. The general purpose is to present an illustrative discussion of the interactions between I/U processes and other contextual features of the R/D&I system, and to demonstrate the applicability and use of the contextual analytical framework by selecting a particular issue of the I/U feature for more intensive investigation. In this manner, it is intended to elaborate on how the method of contextual analysis permits the development of a basis for theoretical analysis, empirical research, policy options and action programs with regard to the I/U function in R/D&I systems.

The particular issue that will be dealt with in depth here is the Structural Attributes of User Organizations. This may be considered to be especially important with regard to the implementation and utilization of innovations.

No claim is made about the exhaustiveness of the treatment presented here. Rather, the coverage of the various topics and of the literature is meant to be illustrative and representative of the total array of contextual issues.

II. IMPLEMENTATION/UTILIZATION

1. Background

Implementation and utilization are the key stages in the process of innovation which determine the extent to which new ideas, products and processes are actually successful in practical, real settings. Historically neglected areas, implementation and utilization became important concerns when research showed that high levels of innovation as measured by adoption decisions were accompanied by low levels of innovation when actual practices were observed, indicating a lack of translation of innovations into practice, and a general tendency in diffusion research to stop at the point where decisions to adopt were made.

While experience in different contexts varies considerably, in general an examination of what happened to innovations after the adoption stage showed that innovations, though adopted, very often were not implemented at all, were transformed during implementation into "more of the same thing", or were withdrawn or terminated shortly after installation. Generally, this lack of implementation was found to be due to (a) a lack of capabilities in terms of skills of operating personnel to deal with the complexities of the innovation; and (b) a resistance to innovation by operating personnel because of attitudes, norms and user system constraints. It is clear that in order to deal effectively with implementation and utilization problems, these attitudinal and capability requirements and issues must be examined. However, attitudinal problems are merely a subset of a total set of issues that require consideration in this context -- something that is not always self evident if one bases one's judgment on the existing research

in this area.

Radnor (1976) points out two major problems of existing research in this field.

1) There is little that has been done with regard to positioning the research in the actual context in which the activity takes place. Questions relating to the kinds of conditions, resources, people, etc. need to be the starting point for research in this area. The general emphasis has been in the "client/researcher" relationship without a recognition of the overall context within which this relationship takes place.

2) Much of the literature deals with the psychological and philosophical issues involved in implementation/utilization (I/U) and normative recommendations are made without a concrete understanding of the tangible, practical factors necessary or important to successful I/U. For example, much of the research emphasizes the values and attitudes that make user system operating personnel resistant to certain kinds of innovations, but does not adequately deal with the technical and structural problems that constrain innovation, and with the kinds of support systems, resources, planning procedures etc. that are required to deal with these problems (e.g.: see Bean et al., 1975).

There is a need to address the problems of implementation/utilization with a recognition of these various issues, and it is largely this need that is met by the contextual analysis framework that constitutes the basis of the current discussion.

2. Concepts and Definitions

Because I/U has been a relatively neglected function, the conceptualization of the implementation and utilization process has tended to be vague and obscure, resulting in a lack of its distinction from other processes/stages of R/D&I. Thus, in many of the models of innovation, the implementation stage either subsumes, or is subsumed by, other stages in the process.

At this point, a brief note of the way in which implementation and utilization are seen in terms of each other is in order. For most purposes, implementation and utilization may be treated as a single function. However, this is not to deny that there exist certain concrete qualitative differences between the two.

These differences are evident from the way in which these terms are used in the literature - sometimes differently, sometimes interchangeably. It is necessary to recognise that both usages have some validity, and that implementation and utilization are not only dissimilar in some ways but also similar. Furthermore, quite often the two functions overlap or coincide, thus making fine distinctions more difficult.

In this paper we recognise these problems of usage and terminology, and address them in our discussion as and when appropriate.

For the purpose of making an initial conceptualization of this function, we refer to the model of the process of innovation suggested by Zaltman, Duncan and Holbek (1973). This model fairly clearly delineates the position of the implementation stage in the overall innovation process, but fails to deal with the acquisition and utilization stages in any detail. However, implementation is seen as comprising (a) the initial implementation substage; (b) the continued sustained implementation substage. Thus, an elementary notion of utilization is present in the model, though it is not explicitly presented as such.

Based on these qualifications, and on our understanding of the innovation process, it is possible to present a modified version of this model which provides an adequate and realistic starting point for the present discussion of implementation and utilization in terms of the total context of the innovation process (Figure 1).

Based on this understanding of the implementation and utilization processes, we may now present the specific definitions of these terms as they are used in this discussion.

1. Implementation subsumes all those processes relating to producer and user activities resulting in at least one trial run of the innovation in the user organization. These activities include installation, testing, debugging and monitoring during and after the trial run.

2. Utilization refers to the processes resulting in the innovation being accepted by the user organization on a continued, sustained basis. These include the processes of routinization, standardization, institutionalization, acceptance and maintenance.

These definitions imply several substages to the two stages which, when taken together describe the complete incorporation of an innovation into a user organization. They also describe implementation and utilization as interrelated and segmental concepts where utilization may be said to commence after a certain time duration or level of implementation. Insofar as there is no significant analytical or descriptive advantage to be gained from establishing a fine and exact distinction between the two phases, we may generally refer to implementation/utilization as one integral process.

Nevertheless, it is also important for analytical purposes to describe in sufficient detail the various dimensions and substages of the I/U process and the relevance or influence these have on overall I/U success or failure. Thus, though we have provided broad definitions of implementation and utilization, it is necessary to understand what are the various processes and characteristics associated with the I/U stage; in other words what are the analytical dimensions of implementation and utilization?

I. Initiation stage

1. Knowledge-awareness substage

2. Formation of attitudes toward the innovation substage

3. Decision substage

4. Acquisition substage

II. Implementation/Utilization stage

1. Initial implementation substage

2. Continued-sustained utilization substage

Modified Zaltman, Duncan, Holbek Model of the Innovation Process

SOURCE: Zaltman, Gerald, Duncan, Robert, and Holbeck, Jonny, Innovation and Organizations, John Wiley and Sons, New York, 1973.

FIGURE 1

III. ANALYTICAL DIMENSIONS OF IMPLEMENTATION AND UTILIZATION

Based on the definitions of implementation and utilization presented earlier, and on the understanding of this function as involving a more or less continuous process, one may describe I/U by means of a cycle that commences during or soon after the acquisition stage and continues through sustained and stable utilization. Figure 2 depicts this cycle and permits us to identify the various substages that are relevant for our purposes.

It is important to note that the cyclical schematization of the I/U function in Figure 2 is not meant to imply a progressive linearity to the process of I/U, with each stage following the preceding one. Indeed one of the major arguments made with regard to the analytical framework is that the entire process of innovation consists of several interactive dimensions and functions, and that stages which may be seen as occuring later can quite well be the earliest to begin. For example, user acceptance of an innovation may take place long before the need-identification stage, and can even influence the need-identification stage in terms of particular choices over others.

A recognition of this interactive nature of the R/D&I process is vital to an overall contextual understanding of the I/U function. Thus, even though the manner of presentation here is sequential, dealing with one feature or issue at a time, this is not meant to imply any "determinate" sequence of events to the process.

Based on this diagram and the approach that we bring to this analysis, the analytical dimensions of the I/U process can be categorized as follows:

1. Implementation/Utilization Processes

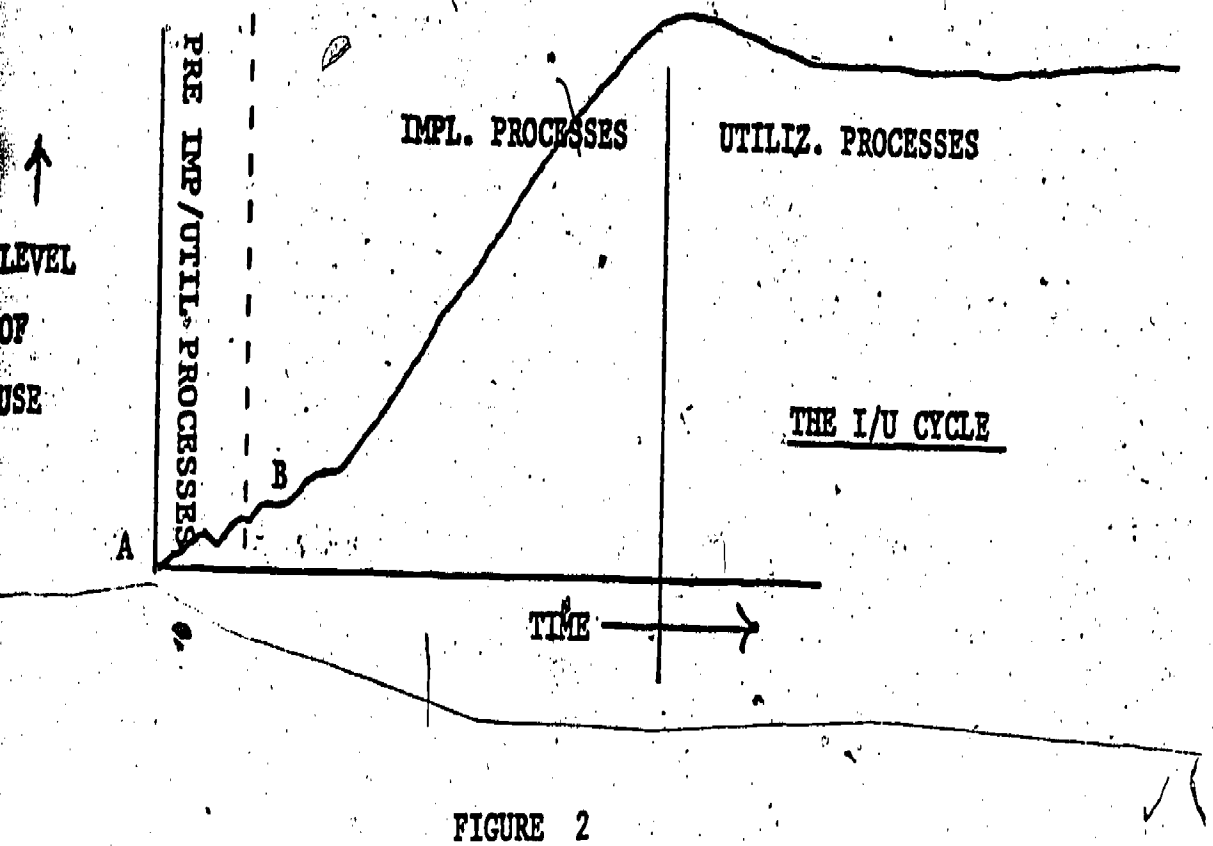

FIGURE 2

Implementation and Utilization Cycle

2. Implementation/Utilization Process Characteristics

3. Producer/User Characteristics

We elaborate on each of these below.

1. Implementation/Utilization Processes

A. Pre Implementation/Utilization Processes

These involve those activities which result in the initiation of the innovation process in the user organization. Three important processes that frequently precede any actual introduction or utilization of an innovation are:

a. Knowledge-Awareness Formation

In most (though not all) cases prior to the actual adoption and use of an innovation, there must be an awareness of its existence and a recognized need for it. This process then is a natural and normal precursor to any subsequent innovation processes.

Generally, there has been some lack of clarity as to whether the existence of a need leads to the development of an innovation (market "pull") or the existence of an innovation generates a need for it (market "push"). According to Rogers and Shoemaker, empirical research does not provide a definite answer. The situation in reality is most likely that it is not one or the other, but both, and the issue of whether needs generate innovations, or vice versa, is a situation-contingent, context-specific and interactive issue.*

*See for example the studies of von Hippel (1976 and 1977) in which he found the users to have the dominant role in several high technology areas.

b. Formation of Attitudes Toward the Innovation

Along with the initial awareness of an innovation (or at least recognition that a change in established ways must be explored), attitudes towards innovation in general, as well as towards specific new items under consideration are also important.

These attitudes include such dimensions as receptivity to innovation, perceptions of the impact of the innovation on the organization, perceived threats to status and power structures, and attitudes about the organizations capability to use the innovation.

The attitudes that are formed at this stage play a critical role in the success of the innovation of particular importance in the extent to which individual attitudes are compatible with overt behavioral requirements of the innovation. Resistance to innovations in the user organization can often develop at this stage in the process.

c. Decision to Adopt or Reject the Innovation

The third pre-implementation process is also important before actual implementation begins (or does not take place). Generally, once the decision to adopt is made, the stage is set for beginning the concrete implementation and utilization of the innovation.

It is important to look at the decision substage discretely because it is during this stage that the various factors that influence the initial conditions for innovation come together with the priorities of the user organization and translate into a tangible, operationally relevant outcome; i.e., a

decision. The nature of this decision and the goals or objectives it is supposed to accomplish have important implications for how the implementation and utilization proceeds.

In the description of these pre-implementation and utilization processes, there has been some overlap with issues and factors that really belong to earlier features such as acquisition or adoption. This is both unavoidable, given the situation that such overlap is reflected in real life conditions, and intentional, because it permits us to indicate how certain processes that may take place during acquisition etc. have direct relevance to the manner in which I/U is undertaken.

B. Implementation Processes

These include all the substages that take place between points B and C on the I/U curve in Figure 2, and which are concerned with installation, initial trial runs, and build-up to capacity levels. These include:

a. Preparatory Activities

Initial preparations must be made by both the producer and the user of the innovation in order to facilitate and create favorable or required conditions for installation.

b. Installation

This may be in the form of installation of new machinery and equipment, launching of a new program, introduction of a new administrative system, etc.

An important aspect of installation is that many hitherto unforeseen or unexpected obstacles to the innovation in the form of resentments and attitudinal obstacles that had been pushed beyond threshhold limits become apparent through direct contact with the innovation.

c. Testing/Debugging

No system is perfectly suited and designed for its new organizational environment, and no matter how confident one may be that all foreseeable problems have been taken care of, the importance of testing and debugging a new innovation cannot be understated. The problem of testing is more vague, and hence more important, in the case of non-embodied innovations such as new classroom techniques, etc., than in the case of machines and equipment. The main objective in this stage is to check if (a) the system components work as they are supposed to, (b) the system does not have any built in defects or "bugs", (c) the components are well "matched" with each other.

d. Trial Run

Though there is some overlap between the testing/debugging stage and the trial run stage, an important distinction is that testing and debugging may be carried out on individual components of the system and may only entail short, limited runs, whereas the trial stage involves the operation of the total system, with all its components, for the first time and for a relatively longer period of time.

e. Monitoring/Evaluation/Feedback

Identification of defects, inadequacies and inconsistancies, as well as the evaluation of the impact and success of the innovation on the basis of its initial operation, constitute an important substage in the implementation process. During this stage modifications and adjustments may be made, feedback is obtained, and overall appraisal of the innovation, its consequences and its problems is possible.

C. Utilization Processes

We have earlier made the argument that implementation and utilization basically constitute an integral process, and that the differences between them are largely qualitative. Nevertheless, it is useful to describe utilization processes separately insofar as they relate to a different portion of the curve in Figure 2. This adds to the richness of the analytical dimensions we are describing here.

Though this may result in some overlap of processes, the basic difference between the tentative and initial nature of implementation, and the more stable, sustained nature of utilization. raises the possibility that processes which seem similar may indeed have different implications during utilization than during implementation. Furthermore, we prefer in such cases to err in the direction of redundancy rather than risk the omission of what may be key issues.

The main processes in the utilization stage are as follows:

a. Replacement/Modification of Existing Equipment

The introduction of an innovation into an organization has direct implications for existing equipment and systems.

Either the new innovation is to replace this, or it is to modify and expand on the ongoing activities. Thus, an important factor for consideration is the manner in which the new innovation necessitates changes in existing equipment or style. Prior to any stable utilization of the new innovation, issues and actions related to this situation need to be addressed.

b. Routinization and Standardization

It is during this phase that the incorporation of the innovation in the organization takes on a stable and mature dimension. The development of routines for behavior and problem solving, and the generation of standards and rules with regard to the new innovation is a fairly arduous process that needs to be gone through before the innovation can truly be said to have become a "part" of the organization.

c. Institutionalization

The routinization and standardization process leads to the eventual institutionalization of the innovation in the organization. It is during this period that organizational structures, working patterns and rules and regulations crystallize and take tangible forms and meanings in relation to the innovation.

d. Monitoring/Evaluation/Feedback

Just as during the implementation stage, the careful evaluation and monitoring of the operations and outcomes of the innovation, and the appropriate modifications and design and development of feedback systems are important processes in utilization. In order to ensure continued-sustained operation, it is necessary to ensure reliable and accurate monitoring

and evaluation mechanisms. Monitoring/evaluation/feedback during utilization is different from the same process in implementation to the extent that here the emphasis is more on long term stable operation rather than short term, initial testing and evaluation, and thus the design and development of adequate feedback and monitoring systems plays an important role.

e. Maintenance and Acceptance

In order to give the innovation a more permanent and continuous capability in the organization after it has reached a stable level of utilization, adequate measures need to be taken to ensure that the techniques, programs and systems are maintained in working order. Organizational and operational problems need to be continually dealt with and this implies the need for a continuous maintenance operation.

Alongside this process is the gradual acceptance of the innovation by the members of the organization. Though initial resistance and obstacles may have been overcome earlier, it is only after the innovation has been in use for some time that one can examine and discuss the extent to which it has been accepted in a positive manner by the members. This final attitudinal issue is a critical one and depends to a large extent on the degree to which the decisions, strategies and structures associated with utilization, were undertaken or designed with a view to the encouragement of long term stable acceptance of the innovation by the individuals concerned.

f. Extension/Improvement/Additional Functions

Once the innovation has reached a stable level of utilization and has been operating in this manner for some

time, there may arise situations or needs which require the extension or improvement of the functioning of the innovation, or the addition of new functions.

In some cases, this may ultimately lead to the adoption of a new innovation by the organization. Generally this stage characterizes the period between innovations and constitutes the key link that connects this cycle with the next cycle of innovation. Extensions and improvements might be continuing on the current innovation even as decisions and processes are taking place with regard to the acquisition and adoption of a new innovation. To a large extent what happens during this stage determines whether or not the innovation is going to be replaced or not. If the innovation cannot be extended or improved upon to address new and emerging organizational needs, then the pressure to acquire a new innovation will be greater.

So far, we have described the various sub-processes that constitute the overall I/U stage. Our emphasis has been on the detailing of the constituents of these processes and their implications in terms of analysis. In this sense, the analytic dimensions thus far discussed have value mainly in their capacity as descriptive categories of the I/U function. They still leave unanswered, or unaddressed, issues that relate to the explanation and prediction of I/U behavior, and the translation of these issues in terms of practical and tangible behavior of the various entities involved in the process. The remainder of this section will deal with these issues.

First, we must look at how the different processes of the I/U function influence (or are influenced by) contextual features. It is by examining the nature of these interactions that we can better explain and predict I/U process behavior. Towards this end, we identify sets of process characteristics; i.e., attributes of the I/U process, which are modified

or in turn modify contextual factors, associated with the various processes already described, and briefly examine their meaning for the overall I/U function.

Secondly, in order to give our analytical base further practical relevance, we must look at the concrete entities that participate in the I/U process, and explore (a) their characteristic structures and attributes; and (b) how these attributes and characteristics interact with various elements of the I/U process.

Basically, there are two types of entities that are of importance, producer organizations and user organizations, and we shall focus our attention on the characteristics of these organizations and the nature of relationships between producers and users in order to understand how these interact with I/U processes.

However, our discussion of these next two sets of analytical dimensions, namely I/U Process Characteristics and Producer/User Organizations, will not be as detailed as the above discussion of I/U Processes. This is in keeping with the illustrative and demonstrative emphasis of this analysis. Thus, instead of exploring in detail the micro features of these analytical dimensions, we shall present some general comments about each of the sets, and a listing of their particular components.

2. I/U Process Characteristics

Associated with the various subprocesses of implementation and utilization are certain process characteristics. We may understand these as indicators, measures, or descriptors of conditions and constraints which, in interaction with contextual factors, modify the behavior and operation of the various I/U processes. In this sense, they may be understood as those characteristics of the I/U process which link it up with contextual factors in an analytically relevant manner.

Thus, for example, an important characteristic of the pre-implementation/utilization process is the level and scope of producer/user contact

prior to implementation. This factor will play a major role in determining the nature of the knowledge/awareness substage and the problems/issues that emerge at this point. Furthermore, the level and scope of producer/user contact will itself depend on contextual factors and constraints.

To give another example, the process changes resulting from implementation will have a strong influence on the way in which the implementation process progresses and the contingencies it faces. Contextual factors such as organizational resistance to change and formalization of organizational structure will in turn influence the types of process changes that result from implementation.

The various characteristics associated with the subprocesses of the I/U function are listed below.

(a) Pre-Implementation/Utilization Characteristics
  (i) Level and Scope of Producer/User Contact Prior to Implementation.
  (ii) User Information Seeking Style
  (iii) Level of Formalization of User Decision Making and Evaluation Processes

(b) Implementation Characteristics
  (i) Level and Scope of Implementation Activities
  (ii) Technical and Skill Requirements
  (iii) Processual and Structural Changes Resulting from Implementation
  (iv) Adjustments Required by Implementation

(c) Utilization Characteristics
  (i) Scope and Level of System Adaptation Required for Successful Utilization
  (ii) Conditions for Sustained Utilization
  (iii) Structural and Processual Changes Resulting from Sustained Utilization

(iv) Adjustments Required During Sustained Utilization

(v) Constraints on Utilization

3. Producer/User Characteristics

The final set of analytic dimensions are those dealing with the producer and user organizations and their interrelationships. The characteristics of the structures and methods of functioning of these organizations are important influences in the success of implementation and utilization, and an understanding of the various issues that are important in this context is vital to successful implementation and utilization.

It is necessary to note here that whereas the I/U processes and process characteristics described earlier are directly related to the I/U feature, producer/user characteristics are not necessarily as directly connected, but still remain equally important since the practical outcome of implementation and utilization is to a large extent dependent on the structures, strategies and methods of operation of the producer and user organizations. It is for this reason that we include producer and user characteristics as a necessary subset of the analytic dimensions of I/U.

For example, the ability of the producer organization to train user organization members in the operation of the new innovation will be a major influence on the successful implementation and use of the innovation. Thus, it is not enough for the producer organization to provide training facilities for user members. It must also be capable of effectively administering the required training in the appropriate manner.

To give another example, the existence or non-existence of change agents, their prior experience, power positions and degree of legitimization within the user organization will be major determinants of the ease with which the innovation gains acceptance and is actually

implemented in the organization. The location of these change agents and the strength of the linkages between producer organization members and such agents will also be important factors in this context.

Producer/user characteristics can be subdivided according to whether they relate (a) to producer organizations, (b) to user organizations, (c) to the relationship between producers and users. However, a point needs to be made about such a categorization. The distinction between producer and user organizations is a functional distinction and does not necessarily mean that the two are always different from each other. In many instances of innovation, the producer organization is the one which is also the user. This is particularly a common occurrence when one unit in an organization develops an innovation which is to be used by another unit.

The importance of the distinction is in terms of the different problems and issues that arise in each. Thus, an organization in its role as a producer faces certain problems and decisions. The same organization, in its role as a user, faces a different set of issues.

Finally, the relation between producers and users acquires a broader meaning when seen in this context. Thus, producer-user relations does not refer only to relations between two different organizations, but can also refer to internal relations between units within the same organization.

With these points in mind, we may now list the various characteristics of producer/user organizations.

A. Producer Organization Characteristics

a. Producer Implementation Capability
b. Ability to Train User Personnel
c. Role of Key Producer Personnel in I/U

d. Service Capability
e. Technical and Human Resources
f. Producer Organization - Environment

B. User Organization Characteristics

a. Barriers/Incentives to Innovation
b. User Implementation Capability
c. Innovation Entry Points
d. Role of Key Personnel in I/U
e. Status Relationships Among Innovators
f. User Organization Structure

C. Producer-User Relationship Characteristics

a. Producer-User Communications Channels
b. Past Experiences Between Producer and User
c. Hierarchical Locations of Producer-User Linkage Points
d. Stability and Reliability of User Relation With Source of Innovation

This completes our discussion of the analytic dimensions of implementation and Utilization. The three sets of such dimensions are:

1. I/U Processes
2. I/U Process Characteristics
3. Producer/User Characteristics

and are summarized in Figure 3. Although this list of dimensions does not claim to be exhaustive in its coverage of all the issues in I/U, it does provide a fairly representative and comprehensive perspective on this feature.

ANALYTIC DIMENSIONS OF THE

IMPLEMENTATION AND UTILIZATION FEATURE

1. I/U PROCESSES

A Pre-Implementation/Utilization Processes

B Implementation

C Utilization Processes

2. I/U PROCESS CHARACTERISTICS

A Pre-Implementation/Utilizaton Characteristics

B Implementation Characteristics

C Utilization Characteristics

3. PRODUCER/USER CHARACTERISTICS

A Producer Organization Characteristics

B User Organization Characteristics

C Producer-User Relationship Characteristics

→ (Selected for intensive investigation)

FIGURE 3

IV. SELECTING AN ISSUE FOR CONTEXTUAL ANALYSIS

As mentioned earlier, the major purpose of this paper is to present an illustrative contextual analysis of a particular issue of the I/U feature, in order to elaborate on how this method of analysis permits the development of a basis for theoretical and practical analysis with regard to I/U in R/D&I. This involves the development of a rich descriptive taxonomy of variables that can be used by both researchers and practitioners involved in I/U. For researchers it may act to provide a more complete description of the I/U phenomenon in its context than has generally been used. For practioners it may provide the basis for strategic decision making as regards the selection and pursuit of programs and projects. An initial elaboration of this system context with respect to implementation issues in operations research has been elaborated by Radnor (1977) and the present discussion is an extension and development of this framework.

We have selected for this purpose, the issue of "User Organization characteristics", which has been briefly discussed in the previous section. Though to a large extent this selection is arbitrary, we do feel that the role and impact of user organization characteristics on the I/U process is a particularly useful issue to investigate in depth in the context of educational R/D&I. However, this is not to downplay the importance of the other dimensions, and we may reiterate here that in order to develop a full comparative contextual analysis, a complete exploration of all the dimensions in Figure 3 is necessary.

1. User Organization Characteristics

User organization characteristics have been described as one set of analytic dimensions of the I/U feature. It is necessary to note here

that alone, these characteristics are neither necessary nor sufficient to insure successful implementation or utilization. However, their very presence or absence, and interaction with other contextual characteristics, influences the configuration of the I/U patterns and processes.

The six user characteristics described earlier, which are by no means exhaustive, provide a fair representation of factors found in the literature. While they vary in the extent to which they have already been the subject of analysis and investigation, each is worthy of further exploration, as noted in the following brief comments.

A. Barriers/Incentives to Innovate

All organizations are not receptive to innovation and such factors as organization structure, resource allocation, skills, inventory and attitudes of members may inhibit innovation and act as barriers to change. Also, the incentive schemes and structures can influence the success/failure of innovations. Incentives may be either internal or external to the organization. In the former category would be organizational rewards such as promotion, salary increases, status and group esteem, top management support, etc. which accompany the innovation career. The latter refer primarily to incentives provided by the system to the innovating organization; e.g.: grants, subsidies, tax relief, etc.

B. User Implementation Capability

The ability of the organization, in terms of its material and human skills, to successfully implement the innovation is an important factor. The increasing rate, level and scope of innovation activities in organizations results from and is an impetus to the development of specialized personnel procedures, improved coordination and control processes, and more efficient

administrative strategies. These specialized resources constitute user capabilities and their design and use are receiving increasing attention in efforts to rationalize I/U processes.

C. Innovation Entry Points

While the physical or structural location of a particular innovation in a given organization may be pre-determined, the initial contact and subsequent negotiations preceding physical implementation activities may be extremely varied. For example, the initial channels of communication may be either formal or informal; or the initial entry point could either be in top management or in a functional unit. Similarly, suppliers, customers, board members, boundary personnel (e.g.: purchasing and sales personnel) and staff, may all serve as potential entry points for innovation. The type and location of the entry point in effect sets the initial conditions for subsequent processes and thus plays a major role in the progress of the I/U process.

D. Role of Key Personnel/Change Agents in I/U

I/U processes are seldom so routinized that the role of individuals in influencing the acceptance or rejection of an innovation can be overlooked. Innovations are often without similar precedent, follow non-routine I/U procedures, have to be implemented under conditions of considerable resistance and have limited funds available. The role of key personnel becomes critical in overcoming these and similar barriers.

Of particular importance are the roles of "product champions", "internal entrepreneurs", change agents and opinion leaders. The first two terms refer to those individuals who are willing and have the resources to follow and "push" an innovation through

all the obstacles and barriers it is likely to encounter to the point where it finally gains acceptance and legitimacy.

Thus, they overcome resistance, absorb uncertainties, resolve conflicts, gather resources, encourage acceptance, and enhance successful implementation and utilization of the innovation.

Change agents and opinion leaders are similarly important, except that their major role is to change attitudes and create favorable conditions for the acceptance of the innovation. They need not necessarily be the "champions" of the innovation, but may just be influential persons with positive innovation attitudes. Also, whereas the product champion generally belongs to the user organization, the change agent or opinion leader may be from either the producer or the user organization, or from a support system.

An important factor in this context is described by Rubenstein et al. (1967) and built upon by Radnor (1972), and deals with how innovative groups sometimes go through a series of life cycles in becoming integrated as an innovative force in the organization. The significance of this historical pattern is that behaviors and strategies (of genuine top management support) might have differential impact and relevance depending on the phase in which they took place.

E. Status and Power Relationships

This factor refers to the relative status of organization members concerned with the innovation process (and more generally with the power and authority patterns in the user organization). For example, what is the relative status in the organization of persons involved in knowledge production (KP) processes as compared to those involved in knowledge utilization (KU) processes? What

are the relative power and status differentials between implementing and utilizing personnel, especially when they are in different subunits?

Further, this problem of relative status extends beyond the organization. For example, membership or affiliation with a professional organization may affect the status within the organization of certain individuals, and also may lead to different group pressures regarding an innovation. Also, members of producer organizations may sometimes be perceived as having higher status than user organization members, which in turn would affect the interaction between the two during the course of I/U.

Finally, the consequences of the adoption of the innovation for status and power relations would play an important part in how different persons approach the innovation and react to it. Those whose status would be adversely affected would tend to be more resistant to the innovation than those whose status will be enhanced. The degree to which the necessary changes in status relations can be made without upsetting the stability of the organization is an important determinant of the extent to which the innovation is successfully implemented and used.

F. User Organization Structure

This is the issue that we have selected for further in-depth analysis. The structure of the organization refers to the relatively stable established patterns of interactions and relationships within the organization, and structural dimensions include such factors as centralization, routinization, complexity and coordination. In general, the structure of an organization describes the level of bureaucratization and rationalization of its activities, and determines to a large

extent the manner in which individuals and groups in the organization interact with each other over periods of time. As far as the introduction of an innovation is concerned, the structure of the organization may present obstacles to its successful implementation and utilization, especially if the innovation requires a substantially different structure from the existing one.

Since user organization structure has been selected for closer focused analysis, we shall further elaborate on this characteristic in the next section.

In Figure 4 are listed the six user organization characteristics that have been described above.

2. Narrowing the Focus: User Organization Structure

In the previous section, we had selected "user organization characteristics" as the subject for closer analysis, and we had described the general dimensions of this issue of the I/U function. We now narrow our focus further, selecting user organization structure as the particular emphasis for further analysis. It should be noted, however, that this selection is not meant to indicate any particular importance to user structure over other aspects of user characteristics.

Our major purpose is to present an illustrative contextual analysis of the I/U function, and the selection of the user organization structure for more intensive analysis has been made with this purpose in mind.

We can, at this point, briefly indicate how we have progressed from our initial consideration of the overall I/U function to our current specific focus on user organization structure. This will not only

USER ORGANIZATION CHARACTERISTICS

1. Barriers/Incentives to Innovate
2. User Implementation Capability
3. Innovation Entry Points
4. Role of Key Personnel/Change Agents
5. Status and Power Relationships
6. User Organization Structure → Selected for Further In-depth Investigation

FIGURE 4

demonstrate the methodology that we are using, but also present the reader with a perspective on this issue in the context of our overall contextual framework.

As shown in Figure 5, our approach has been one of progressively narrowing the focus of our analysis, and at the same time maintaining strong analytical linkages between levels. Thus, we started with the general list of features of the R/D&I system, selected I/U for special analysis, described I/U in terms of its analytic dimensions and chose one for further investigation, and finally arrived at our present level of analysis -- i.e., user organization structure. We still have one more stage of reduction to go through before we actually commence the analysis, and this will be dealt with in the following section.

To return to our discussion of organization structure, this may be viewed from several perspectives. In current organization theory, a general distinction is made between informal structure and formal structure. (Hall, 1977). Mainly, this has been due to a growing awareness that the formal aspect of an organization's structure does not include those dimensions of the organization which are less "visible", more random, and pertain to activities not directly dealing with organizational goals and objectives. This distinction between formal and informal structures is not meant to imply a straightforward dichotomy, but rather to indicate that in several instances, behaviors and situations that occur in the formal sphere cannot be fully understood without a consideration of the informal aspects, and vice versa.

Formal structural dimensions refer primarily to those features of an organization which are designed to establish the framework, procedures and relationships seen as necessary to organization's stable operation and growth. Rules, regulations and formal operating procedures, along with the formal divisions, categorizations and allocations that are established by the organization, are included in this category.

PROGRESSIVE REDUCTION AND

SPECIFICATION OF ANALYTICAL FOCUS

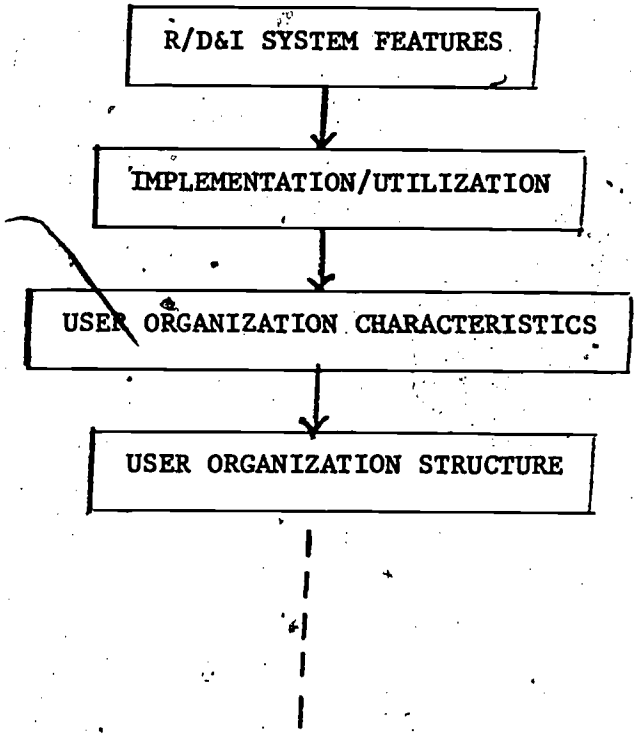

FIGURE 5

Informal structure refers to those patterns and features that emerge or are created either in reaction to the formal structure, or as alternative arrangements that address needs and priorities which are not considered or dealt with adequately by the formal organization. To a large extent, the actual types of interactions that take place on the informal level parallel those that occur on the formal level, and often the only difference between the two is the degree to which these interactions and patterns are officially or formally recognized by the organization. Thus, there can be informal authority structures and communication channels which work as well as, and in practice are indistinguishable from, formal authority patterns and communication channels. At the same time they can be non-parallel and contrasting.

Another important distinction that is made with regard to structural characteristics of organizations is between the attributes of structures and the functions or processes associated with structures. Again, this is a subtle distinction and is not meant to be looked at as a dichotomization of the organizational structure. There is a strong relationship between the structural attributes and the processes of an organization, with each defining and being defined by the other. Thus, for example, we may speak of complexity as being a structural attribute, and of coordination as being the function or process associated with complexity and the need to manage this complexity.

Finally, we may describe organization structure in terms of the overall patterns that characterize them. Several models have been suggested in the literature with regard to this issue, and the one most relevant to our present discussion is Burns and Stalker's (1961) conceptualization of mechanistic/organic patterns. The mechanistic organization is described as inflexible, rigid, and generally less likely to innovate whereas the organic organization is described as responsive, flexible, adaptive and more likely to innovate. Insofar as we are

discussing issues relating to innovation, this distinction is important since it highlights in an explicit manner the conditions that encourage or discourage organizational innovation.

In summary, we may describe organizations in terms of:

1. Formal Structures
2. Informal Structures
3. Processes Associated with Structures
4. Structural Attributes
5. Overall Patterns

Figure 6 presents the main features of these various perspectives on organizational structure. Each of these dimensions of organization structure can constitute the basis for an extensive and meaningful contextual analysis. For our purposes, we make a further reduction in the scope of analysis, and focus on structural attributes of user organizations as the specific topic that we will deal with.

3. Narrowing the Focus Further: Structural Attributes of User Organizations

At this point it is useful to recapitulate the successive features which have been selected to reach a level of analysis sufficiently narrow in scope to yield a useful basis for research and policy analysis. This process is shown in Figure 7, which is essentially an elaborated version of Figure 5 with the addition of the final stage in the process of reduction, i.e., structural attributes of user organizations. The structural attributes noted in this figure are described below:

A. Centralization/Decentralization

This refers to the extent to which decision making and other

USER ORGANIZATION STRUCTURE

FORMAL

1. Authority Patterns
2. Power Structure
3. Delegation of Tasks
4. Vertical and Horizontal Communication Channels

INFORMAL

1. Group Liaison Patterns
2. Leadership Patterns
3. Informal Status Relationships
4. Communication Networks

PROCESSES ASSOCIATED WITH STRUCTURES

1. Coordination
2. Cooperation
3. Planning/Decision Making
4. Operation
5. Control

STRUCTURAL ATTRIBUTES

1. Centralization/Decentralization
2. Formalization
3. Complexity
4. Integration/Differentiation

Selected for further analysis ←

PATTERNS

1. Mechanistic
2. Organic

FIGURE 6

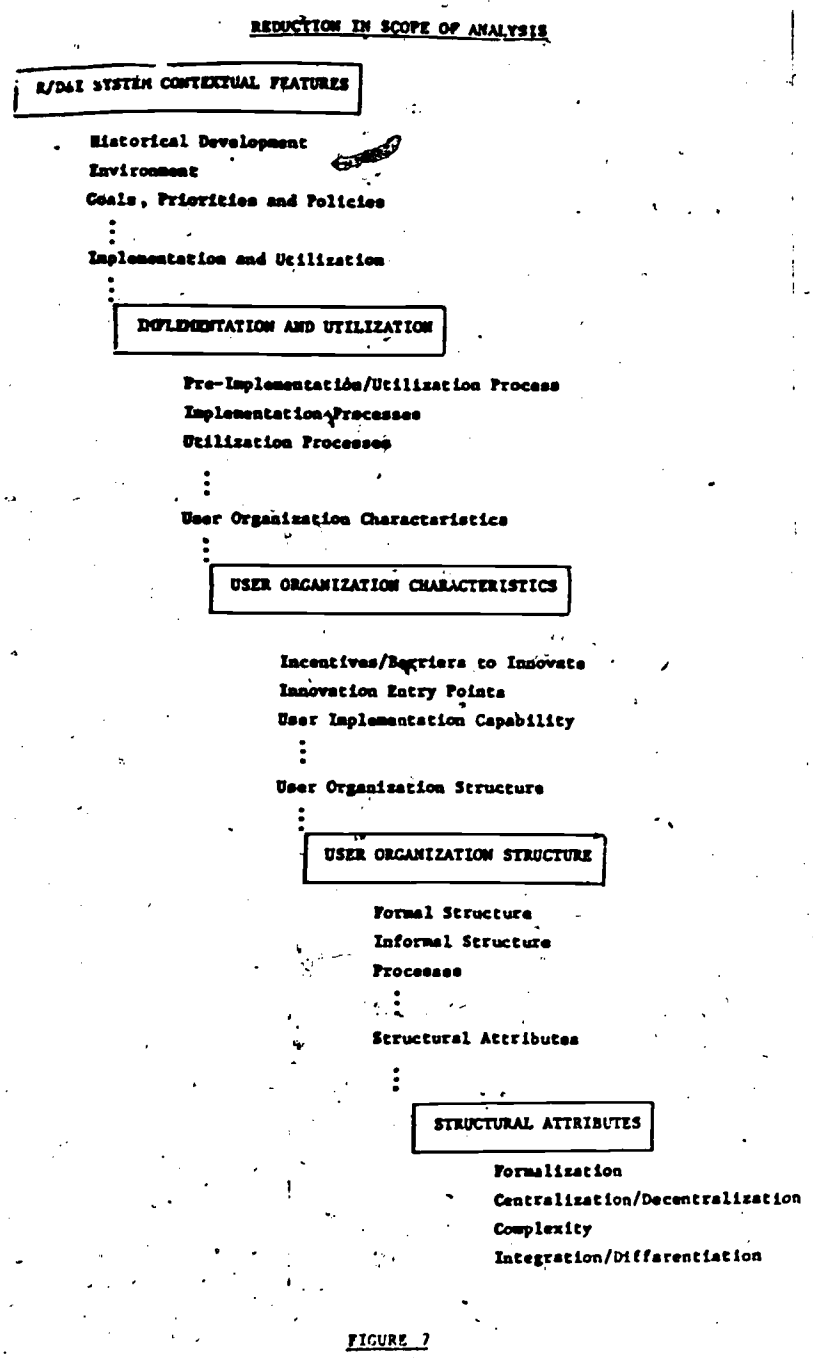
REDUCTION IN SCOPE OF ANALYSIS
R/D&I SYSTEM CONTEXTUAL FEATURES
Historical Development
Environment
Goals, Priorities and Policies
Implementation and Utilization
IMPLEMENTATION AND UTILIZATION
Pre-Implementation/Utilization Process
Implementation Processes
Utilization Processes
User Organization Characteristics
USER ORGANIZATION CHARACTERISTICS
Incentives/Barriers to Innovate
Innovation Entry Points
User Implementation Capability
User Organization Structure
USER ORGANIZATION STRUCTURE
Formal Structure
Informal Structure
Processes
Structural Attributes
STRUCTURAL ATTRIBUTES
Formalization
Centralization/Decentralization
Complexity
Integration/Differentiation

FIGURE 7

administrative practices and responsibilities are concentrated within one or a few units in the organization or are distributed among several units. Centralization has serious implications for the nature of communications in the organization and the types of decision making processes that take place.

Generally, the degree of centralization has implications for the quality and flow of information in the organization. A highly rigid and centralized structure tends to cause members to adhere to specified communication channels. During the initiation stage of innovation where uncertainty and need for awareness require substantial information flows, this can have an adverse impact. In fact, research has shown that less hierarchy of authority and more participation in decision making can increase the information available to the organization and hence increase knowledge awareness at the initiation stage.

During implementation, however, a more specific line of authority and responsibility is required to reduce problems such as role conflict and ambiguity. And furthermore, the decentralized authority and decision structures tend to hinder implementation because it is difficult for the organization to gather enough influence over participants (Zaltman and Duncan 1977).

B. Formalization

This refers to the extent to which formal rules and procedures about organizational activities and behaviors have been formally and officially elaborated and expressed. Organizations that are more formalized are generally characterized by rigid bureaucratic modes of operation. On the other hand, formalization tends to decrease uncertainty in functioning by providing specific and detailed guidelines for eventualities that arise. Though it would be argued, and supported by much of the research, that

successful innovation requires a realtively less formalized structure, during the implementation stage there is a lot to be said in favor of increased formalization. Radnor and Neal (1973) found that the successful implementation of operations research - management science activities in large industrial organizations was facilitated by the development of specific formalized procedures, such as long range planning, scheduling and regular progress reports.

Formalized procedures provide both information and specific techniques which help organizational personnel to use the innovation. A lack of these formalized procedures can lead to role conflict and ambiguity during implementation.

C. Complexity

This refers to the number of occupational specialities in the organization, their extent of their specialization, the degree of differentiation of task structure and the level of complexity of the technology being used. Organizations generally tend to develop increasingly complex structures as they grow and expand and as their range of activities increases. In another sense, complexity may be understood as the necessary concomitant of increased rationalization of organizational structure and activity.

The complexity of an organization's structure is an important factor in the implementation and utilization process to the extent that the actual use of the new innovation entails a confrontation and coordination of this complexity in a situation of change and uncertainty. The introduction of the innovation may run into problems and obstacles that result from the existing complexity which is difficult to manage. Also, high complexity can lead to conflicts which hinder the process of implementation.

Alternatively, implementation and utilization may itself lead to increased complexity by requiring more diversity or subgroup formation.

D. Integration/Differentiation

This is a structural concept that is somewhat closely related to complexity in the sense that a higher degree of differentiation is generally associated with complexity. However, this attribute has a greater relevance in terms of the organization's ability to coordinate its various activities and manage its operations under conditions of uncertainty.

Integration/differentiation generally refers to (a) the extent to which the organization's structure has been subdivided into specialized and discrete subunits designed to deal with the wide range of activities the organization undertakes, and (b) the extent to which the organization has developed coordinating and systematizing mechanisms and roles to enable these various units to work together towards overall organizational goals. A highly differentiated organization which does not possess adequate integrative structures and mechanisms is likely to run into serious dysfunctional problems of uncertainty and lack of coordination.

In the context of implementation and utilization, which generally require an orchestration and coordination of various units and functions in the organization for successful innovation, the issue of integration/differentiation is of special importance. A good example is Sapolsky's (1967) study of innovation in department stores. The object was to introduce innovations in the form of separate buying and selling functions, using computers in merchandising, and implementing sophisticated OR and MS techniques in merchandise problems. However, the diversity in the stores' structural arrangements, their decentralized decision making and the existence of a large number of equally situated subunits (which in effect was an example of high differentiation and low integration) led to frustration of attempts to implement the proposed innovations (Zaltman and Duncan 1977).

V. BRIEF COMPREHENSIVE CONTEXTUAL ANALYSIS OF STRUCTURAL ATTRIBUTES OF USER ORGANIZATIONS

The analysis so far has followed a "reductionist" methodology. On a step-by-step basis, we have gradually narrowed the focus of analysis of the I/U feature until we have reached a level of analysis which is specific enough for an analysis to be manageable, yet still rich enough for meaningful policy analysis. This narrowing of focus is mainly to facilitate the exposition of the application of the contextual analytical framework through the in depth treatment of one issue, and is not meant to detract from the overall interactive nature of the framework. Thus, it is as important to look at the influence of I/U on structural attributes as it is to examine the impact of structural attributes on I/U (e.g.: Bean et al 1975). Generally, even when such relationships are dealt with, one is focused on to the exclusion of the other. To gain a broad, action oriented and comprehensive perspective on this issue, it is necessary to take an integrated approach.

The process of interaction with contextual factors must be explored inductively and deductively, from a theoretical and an empirical basis, and from the analyst's experience as well as the literature. The initial matrix of comparative features as discussed in chapters One and Two provides the basis for a deductive approach to identify contextual interactions, as well as a starting point for literature search, theoretical analysis and empirical investigation.

In the context of this discussion of the implementation and utilization function in R/D&I systems, the basic research question we are dealing with is:

> How do structural attributes of user organizations which influence the implementation and utilization of innovations lead to varying outcomes as a consequence of contextual conditions?

"Context" is defined as the interactive effect of the whole set of

R/D&I system features. To permit full analysis of the issue of "structural attributes of user organization" in the R/D&I system as a function of context variation, it would be necessary to interact this feature issue with each of the R/D&I system features and feature issues. That is to say, we would initially explore the set of research and policy questions that emerge from the interaction of structured attributes as an issue with for example: historical development, environment, institutions, etc. A complete analysis across every feature of an R/D&I system context would be necessary to establish a basis for a full contextual analysis. This is illustrated in outline form in Figure 9.

Figure 9 presents an illustration of how such a full contextual analysis could be done. It should be noted that this analysis does not claim to provide answers—but relies on the knowledge and experience of the analysts with the recognition that the analysis is likely to be improved through a series of iterations as more is learned.

CONTEXTUAL FEATURES / STRUCTURAL ATTRIBUTES	ADAPTATION	CENTRALIZATION/ DECENTRALIZATION	SPECIALIZATION	COMMUNICATIONS	COMPLEXITY	INTEGRATION	DIFFERENTIATION	ROUTINIZATION	INSTITUTIONALIZATION	COORDINATION	FORMALIZATION	
ENVIRONMENTS												
HISTORICAL												
INSTITUTIONAL BASE		X			X	X	X	X	X		X	
GOALS, POLICIES, STRATEGIES												
ADMINISTRATIVE PROCESSES		X			X	X	X	X	X	X	X	
PERSONNEL BASE												
FUNDING												
INFORMATION FLOW												
INNOVATIONS		X			X	X	X	X	X	X		
NEED IDENTIFICATION												
GENERATION/RESEARCH												
DEVELOPMENT												
PRODUCTION												
MARKETING/DISTRIBUTION, ETC.												
ACQUISITION												
IMPLEMENTATION/UTILIZATION		X			X	X	X	X	X		X	
SUPPORT SERVICES												
EVALUATION RESEARCH												
RESEARCH ON R/D&I												

MICROLEVEL ANALYSIS OF INTERACTIONS BETWEEN STRUCTURAL ATTRIBUTES AND CONTEXTUAL FEATURES

Figure 8

VI. IDENTIFICATION AND SELECTION OF CRITICAL INTERACTIONS BETWEEN STRUCTURAL ATTRIBUTES AND CONTEXTUAL FEATURES FOR ILLUSTRATIVE INTERACTIVE ANALYSIS

A complete and systematic analysis of each item in Figure 8 that would be grounded in the literature is beyond the scope of this discussion. In the chapters devoted to the discussions of institutional bases and of entrepreneurship (as a sub-issue within historical development) we developed relatively detailed contextual analyses using the complete matrix and then zeroed in on a more limited set of variables for intensive analysis and discussion. In this chapter we have elected to present this step in an abbreviated fashion and to concentrate more of our discussion on the elaboration of the variables extracted from the detailed contextual review. This review was necessary in order to focus in on questions of both high priority and general applicability to the issue of structural attributes of user organizations. In this review we attempted to extract those key issues which surfaced in the analysis in the sense of their being either critical or pervasive across many dimensions of the R/D&I system context.

1. Initial Identification of Critical Interactive Dimensions

Since a priori there is no reason why some structural attributes should be selected over others, we examine the interactions between the range of structural attributes and contextual features in order to identify those which have the most potential relevance. This process permits us to narrow our focus to a manageable yet relevant level and at the same time maintain the systematic approach we have tak[illegible]all along.

The micro level analysis of the structural attributes and their interaction with major contextual features is necessary to gain some notion of the most significant interactive dimensions. This is presented in Figure 8 . The interactions of most potential relevance have been indicated by crosses. By examining the relative frequencies of these interactions for different structural attributes (across rows) and by combining this with the analyst's own knowledge and experience and with the priorities that emerge from the literature, we are able to identify a set of key structural attributes for closer investigation. These are denoted by shaded squares in the last column in Figure 8 .

By the process described above, we have been able to identify the most "robust" attributes of user organizations insofar as implementation/utilization is concerned. Similarly, the most interactive or "robust" contextual features (with respect to I/U activities) have also been identified and denoted by shaded squares in the lowest row in Figure 9.

Taking these most robust attributes and features and combining them in a matrix, we obtain a simplified perspective on the contextual analysis of the structural attributes of user organizations in implementation/utilization. This is presented in Figure 10.

Again, it should be emphasized that this reduction process is conditioned by the perspective of the analyst. Theoretically, each cell in the matrix in Figure 8 is an area of potential relevance in examining the impact of contextual features on structural attributes.

However, it is a basic assumption of this study that repeated extension, modification and utilization of this matrix will result in identification of the critical contextual features. These may

FIGURE 9

CONTEXTUAL ANALYSIS OF STRUCTURAL ATTRIBUTES OF USER ORGANIZATIONS WITH RESPECT TO IMPLEMENTATION AND UTILIZATION (I/U)

I. ENVIRONMENTS OF THE R/D&I SYSTEM

Political and legal factors influencing I/U

Legal requirements to install a particular innovation

Social and cultural factors influencing I/U

Norms and values for (or against) utilizing a particular innovation

Norms and values influencing the rate and scope of utilization

Economic factors influencing I/U

Funds allocated to the utilization of particular innovations

II. HISTORICAL DEVELOPMENT

Institutionalization of I/U processes

Impact of development phases of R/D&I system on I/U

Critical events in the establishment of R/D&I systems insofar as they affect I/U

Development and critical level of I/U skills to maintain and expand rate of utilization of innovations

Establishment of specialized services to facilitate I/U processes

Time effects

- On diffusion patterns of I/U
- On identification of problems in I/U
- On routinization of implementation processes
- On extent of utilization of innovations

III. GOALS, POLICIES, STRATEGIES

Producer/User differences in goals/policies/strategies with respect to I/U

Differential perceptions of goals/policies/strategies with respect to knowledge utilization within user organizations

Differential perception of implementing and utilizing personnel with respect to innovation

Figure 9 (cont.)

IV. INSTITUTIONAL BASE (NETWORK OF INSTITUTIONS)

Inter-system linkage with respect to I/U

- Producer/user linkage patterns during I/u processes
- Extent of user ability to work with a variety of producer types during I/U
- Extent of producer ability to work with a variety of user types during I/U
- Extent of producer and/or users to work with support systems during I/U
- Interface structures and liaison arrangements between producer/user/support systems
- Relative scope of responsibility of producers and users in I/U
- Relative amount of initiative of producers and users in I/U system
- Extent of producer/user contact prior to I/U

Intra-system configuration with respect to I/U

- Interface structures of subsystems involved in I/U
- Characteristics of I/U activities
  - Specialization
  - Formalization
  - Complexity
  - Routinization
  - Redundancy
  - Seriality
- Submit interdependence

R/D&I system functions with respect to I/U

- Extent of cooperative (and competitive) efforts among institutions regarding I/U
- Extent of cooperative (and conflicting) efforts within institutions regarding I/U
- Primary loci of I/U activities in R/D&I system
- R/D&I system decision processing relating to I/U activities
  - Producer
  - User
  - Superordinate/coordinate/subordinate systems
- R/D&I system communication network for I/U activities
- R/D&I system authority and influence patterns which affect I/U activities

Figure 9 (cont.)

Relative status of I/U activities in comparison with other R/D&I system activities

Group Processes in Relation to I/U

Dependence of I/U on group versus individual activity

Specialization of a single group regarding I/U activities

Sequential activity of several groups regarding I/U activities

Role of I/U of innovations in growth, change and development patterns of R/D&I system and its component organizations

Integration and differentiation of I/U functions in the R/D&I system.

V. NEED IDENTIFICATION

Need identification processes as they influence I/U activities

Extent to which structural attributes of user organizations are taken into account in identifying the need for a different approach by users

Extent to which structural attributes of user organizations are recognized in translating needs into innovation requirements

Linkage between need identification activities prior to, during, and following I/U activities

Locus of need identification process

Extent to which I/U activities serve as a source of need identification

Need identification process characteristics

Extent of communication gaps between need identification processes and I/U processes

Extent of separation (or overlap) in need identification and I/U processes

Relative specialization of organizational structures for need identification and I/U

Need identifiers

Implementers as need identifiers

Differing characteristics of need identifiers and implementers

- Level of specialization
- Level of education and experience

Figure 9 (cont.)

VI. GENERATION/RESEARCH

Search process characteristics

Extent to which I/U activities are examined in the search for innovation opportunities, ideas for innovations, or modifications in innovations

Ability of personnel involved in I/U activities to identify innovation opportunities

Research process characteristics

Relative level of sophistication and creativity of research and I/U activities

Commonality of knowledge base and sources for research and I/U personnel

Extent to which user requirements, including structural characteristics, are taken into account in research activities

Locus of idea generation activities

- Internal to user
- External to user

I/U requirements for continuous linkage with idea generation capability

VII. DEVELOPMENT

Product and process design and engineering requirements

I/U activities as design parameters

- Modifications in current innovation
- Modifications in subsequent innovations

Customizing of innovations as a result of individual user I/U activities

Pilot scale operations (PSO), prototype development (PD) and testing procedures (TP)

Need for user involvement as a pre-implementation activity

PSO, PD, and TP as methods of initial implementation

User organization structures PSO, PD, and TP

Uniqueness of target user when producing and using innovations are done by different organizations

Development process characteristics in relation to I/U activities

Relative level of technological sophistication of development and I/U processes

Figure 9 (cont.)

Producer/user interaction patterns between development I/U activities

- . During development
- . During I/U

Locus of development activities

- . Internal to user
- . External to user

VIII. PRODUCTION

Production processes

Extent of feedback activities from I/U activities to production

Flexibility of production process to incorporate feedback from I/U activities

Process characteristics

Relative amount of standardization in production and I/U activities

Cost of I/U activities relative to production costs

Relative level of technological sophistication of production and I/U activities

Relative rate technological change incorporated in production and I/U activities

Use of multiple source of production for innovation comments

IX. MARKETING/DISTRIBUTION/DISSEMINATION/DIFFUSION

Market research

Assessment of user I/U capability in determining product requirements

Assessment of user needs for the innovation

Marketing

Implementation activities during test marketing

Adjustment to user organization structure during implementation

Design and development of producer services for implementation

Producer/user liaison relationships during test marketing

Figure 9 (cont.)

Customer Services

User service requirements for initial implementation

User service requirements for sustained utilization

Distribution

Relative emphasis on service during I/U activities by alternative distribution channels

User organization structure as a determinent of market segmentation

Technology Transfer/Diffusion

Technology as a determinant of I/U requirements

Impact of I/U activities on diffusion pattern

- Facilitating diffusion
- Inhibiting diffusion

X. ACQUISITION

Structural characteristics of the user as they affect the relationships between acquisition and I/U activities

Specialization of acquisition and I/U activities

Separation of acquisition and I/U activities

Communication channels between acquisition and I/U activities

User organization structure as a source of innovation selection criteria

I/U capabilities to deal with change

Formalization of procedures governing introduction of innovations

XI. IMPLEMENTATION AND UTILIZATION

Pre-implementation/utilization processes

Knowledge/awareness of organization structural constraints in search for innovations

Organization structure as a factor in attitude formation with respect to innovation

Decision processes

Routine/non-routine decision-making structures

Formalization of decision-making structures

Figure 9 (cont.)

Pre-implementation/utilization process characteristics

Formationalization of producer-user interface structure

Structure attributes of user information system

Implementation

Structure of implementation capability

- Degree of specialization
- Degree of integration
- Extent of openness
- Evaluation and feedback procedures
- Intergroup interface structures

Process characteristics

Impact of technology being implemented on user organization structure

Organization changes resulting from implementation process

Interdependence of implementation and utilization activities

Adaptability

Changeability

Utilization

Structure of subunit utilizing innovation

- Flexibility/stability
- Centralization/decentralization
- Complexity
- Formality/informality
- Intergroup interface structures
- Specialization
- Integration
- Adaptability
- Changeability

Process characteristics

Impact of technology on user organization after sustained utilization

Organizational changes resulting from utilization process

User organizational characteristics influencing implementation/utilization processes

Organization structure as a barrier to innovation

Organization structure as a facilitator of innovation

Innovation entry points as a function of user organization structure

Centralization of decision-making authority

Loci of external contacts in user organization

Figure 9 (cont.)

Structure characteristics of user capability to select, adapt, utilize, maintain and modify innovations

Seriality of these functions in specialized units

Balanced development of these capabilities

Structural characteristics of users as a function of adapter categories

- Innovators
- Early adapters
- Early majority
- Late majority
- Laggards

Reinforcement of change agent activities by specialized organization arrangements

Legitimating of changeability in specialized staff organization

Assistance to line managers acting a changeability

Organization structure as a status building (or detracting) factor for implementers and/or utilizers of innovations

Location of implementers and utilizers in organization hierarchy

Relative status of implementers and utilizers

Producer characteristics influencing organization of user implementation/ Utilization

Producer capability to develop user organization and personnel during implementation

Producer capability to provide continuous assistance to user organization over a period of sustained utilization

Producer/user relationships

Interface configuration and liaison relationships between user and sources of information during I/U activities

Inter-organizational arrangements between users and producers during I/U

Permanence of relationship

Prior Utilization of particular user-producer relationship

Formalization of relationship

Differential in level of development of user and producer organization

Specialized user and/or producer interface arrangements, specialized organizations, liaison arrangements, communications channels or authority patterns established during I/U activities

Figure 9 (cont.)

XII. EVALUATION RESEARCH

User organization structure as an evaluation criteria

As a factor influencing success (or failure) implementation or utilization process

As a factor determining future innovations requirements

As a factor suggesting or requiring modifications

- In the organization
- In the innovation

XIII. SUPPORT SERVICES

User linkage with support systems

- During implementation
- During utilization

User ability to utilize support systems

- During implementation
- During utilization

XIV. ADMINISTRATIVE PROCESSES

Relation to superordinate system administrative processes to I/U processes in user organization

- Policy formulation functions
- Authority and control functions
- Planning and facilitative functions
- Advisory and consultive functions
- Communication channels
- Organizational linkage to I/U activities

Relation of coordinate system administrative processes to I/U processes

- Advisory and consultive functions
- Information distribution functions
- Communication channels
- Organizational linkage to I/U activities

Relationship of intra-organizational administrative processes to I/U activities

Linkage between administrative elements of R/D&I system prior to I/U activities with I/U activities (see also '4' above)

Priority assigned to innovative activities of the type under consideration

Policies set governing I/U activities

Figure 9 (cont.)

Recognition of importance of I/U activities

Assignment of risk to organizational units during I/U activities

Provision for development of specialized personnel for I/U activities

Utilization of specialized management techniques to improve I/U processes

Accountability for I/U activities

Responsibility for I/U activities

Establishment and utilization of specialized procedures to monitor control and evaluate I/U activities

Coordination of I/U activities among relevant organizational subunits

Decision-making procedures governing I/U activities

- Specificity of rules and procedures
- Degree of participation in decision making
- Degree of impersonality of decision making
- Hierarchy of authority
- Homogeneity of decision making
- I/U subunit representation in decision making process
- Centralization/Decentralization of decision making structure

System design and development

- Extent to which I/U activities are explicitly designed (versus evolved)
- Provision for changing I/U activities as a systematic basis

XV. PERSONNEL BASE

Specialization of I/U units with respect to personnel base and training

Organization status systems between implementing and utilizing units

Skill mix/mass required for implementation

Specialization of I/U personnel

Local/cosmopolitan orientation of I/U personnel

Differences in characteristics of implementing and utilizing units

Figure 9 (cont.)

XVI. FUNDING

Characteristics of funding process which influence I/U activities

Adequacy of funds allocated to I/U activities

Regularity and stability of funds allocated to I/U activities

Regulations governing funds to I/U activities

Responsiveness of funding system to changing I/U needs

Organizational constraints in the allocation of funds to the implementation, utilization, and maintenance of innovations

Budgetary process in user organization

Participation of I/U personnel in determining budget governing their activities

Flexibility of budget procedures to changing I/U requirements

XVII. INFORMATION FLOW

Structural characteristics of user information networks during I/U process

Information channels

- Availability
- Utilization
- Performance characteristics

Information dissemination patterns

XVIII. INNOVATIONS

Decision making structures required to initiate implementation of different types of innovations

- Optional
- Authority
- Collective
- Contingent

Organization attribute as a factor influencing the type of innovation implemented

- Complexity
- Size
- Centralization
- Formalization
- Ratio of professional to non-professional
- Cohesiveness of group membership
- Homogeneity of group members
- Interpersonal relationship
- Technological processes

Figure 9 (cont.)

Technological level of innovation as basis for I/U activities

- Current state-of-arts relevant to innovations
- Reliance on "science" versus "art" in I/U activities

Innovation attributes which influence the I/U processes

Implementation

- Terminality
- Interpersonal relationships
- Public versus privacy

Utilization

- Susceptibility to successive modification
- Gateway capacity
- Gateway innovation

be identified by a synthesis of past research on I/U activities, by an extension of findings to related matrix cells, and by deduction or induction from the matrix. In all cases this process also results in a basis for further research.

The critical structural attributes that have been identified by this process are:

1. Formalization
2. Integration/Differentiation
3. Routinization
4. Institutionalization
5. Complexity
6. Centralization/Decentralization

The critical contextual features similarly identified are:

1. Institutions
2. Implementation/Utilization
3. Administration
4. Innovation

2. Selection of A Subset of Critical Interactive Dimensions of Structural Attributes and Contextual Features for Illustrative Analysis.

Figure 10 includes all the key interactive dimensions of interest to our analysis. This provides a basis for the formulation of a variety of topics for more intensive analysis, with each row, column, or box in the matrix being a potential area for inquiry and analysis. For example, "institutionalization of I/U processes" can be examined in terms of any or all of the contextual features. A given contextual feature, such as "administration" can be examined in terms of all the indicated structural attributes. Finally, one could look at a specific interaction, for example the relation between "formalization" (a structural attribute) and "innovations" (a contextual feature).

CONTEXTUAL FEATURES

STRUCTURAL ATTRIBUTES	INSTITUTIONS	IMPLEMENTATION/ UTILIZATION	ADMINISTRATION	INNOVATIONS
Formalization				
Integration/ Differentiation				
Routinization				
Institutionalization				
Complexity				
Centralization/ Decentralization				

IDENTIFICATION OF KEY INTERACTIVE DIMENSIONS BETWEEN STRUCTURAL ATTRIBUTES OF USER ORGANIZATIONS AND CONTEXTUAL FEATURES

FIGURE 10

However, each of the contextual features listed in Figure 10 can itself be discussed in more detail. For example, "Institutions" deals with (a) intersystem linkages, (b) intrasystem linkages, (c) R&D system functions, etc. This added detail permits a more specific set of interactive dimensions to be selected and so in Figure 11 we repeat the matrix in Figure 10 but with the contextual features described in more detail.

The shaded areas in Figure 11 denote the particular topics that we have selected for our illustrative analysis. In the process of our analysis thus far we have greatly reduced our focus of analysis--to a level of greater specificity. It may be argued that such a micro level of analysis has little utility in terms of the general problems of I/U. Our contention is that such a micro-analysis, insofar as it derives from a broad and general systems perspective of the R/D&I context and progressive levels of reduction does not lose "sight" of the overall system and because this process of reduction permits an identification and systematic analysis of the key critical factors in the process, has significant implications in terms of research and policy use.

From Figure 11 we may now draw out those topics that we have selected for illustrative analysis. Figure 12 summarizes these topics and also includes the particular sub-issues of each of these topics that we will be looking at. The matrix in Figure 12 thus presents the total array of dimensions and issues that we are now concerned with.

The sub issues that have been listed under the main contextual headings are defined and discussed below:

A. Pre-Implementation/Utilization Processes

Those user activities resulting in the initiation of the innovation process.

Knowledge-Awareness
Attitude Formation
Decision to Adopt

	INTEGRATION/ DIFFERENTIATION	ROUTINIZATION	INSTITUTIONALIZATION	FORMALIZATION	COMPLEXITY	CENTRALIZATION/ DECENTRALIZATION
INSTITUTIONS						
1. Intersystem Linkages						
2. Intrasystem Linkages						
3. R&D System Functions						
IMPLEMENTATION/UTILIZATION						
1. Pre I/U Processes	X			X	X	X
2. Pre I/U Characteristics						
3. Producer-User Relations						
ADMINISTRATION						
1. Superordinate						
2. Coordinate						
3. Intra-Organizational	X			X	X	X
INNOVATION						
1. Attributes	X			X	X	X
2. Type	X			X	X	X
3. Perceived Attributes						

KEY INTERACTIVE DIMENSIONS WITH ELABORATED CONTEXTUAL FEATURES AND IDENTIFICATION OF TOPICS SELECTED FOR ILLUSTRATIVE ANALYSIS

FIGURE 11

Structural Attributes of I/U Processes

Comparative Features of Contextual Analysis	Formalization	Complexity	Centralization/ Decentralization	Integration/ Differentiation
Pre I/U Process				
-Knowledge/Awareness				
-Attitude Formation				
-Decision to Adopt				
Intra-organizational Administrative Processes				
Decision-Maker Characteristics				
-Goal Orientation				
-Time Perspective				
-Interpersonal Orientation				
-Sub-unit Membership				
-Openness				
Innovations				
Attributes				
-Technological Level				
-Programmed/Unprogrammed				
Types				
-Optional				
-Authority				
-Collective				
-Contingent				

TOTAL ARRAY OF SELECTED INTERACTIVE DIMENSIONS

FOR ILLUSTRATIVE CONTEXTUAL ANALYSIS

FIGURE 12

B. Intra-Organizational Administrative Processes

Refers to all user in-house management processes such as decision making, planning, organizing, coordinating, controlling, evaluating.

a. Decision Making Characteristics

Focus - Point in the organization where an individual or group makes a decision.

Flexibility - The ease with which a decision structure can be modified.

Hierarchy - Extent to which decision structure is organized in a clearly defined chain of command.

Re-configuration - Extent to which decision making structure is re-formed to make a different type of decision, i.e., adoption, acquisition, implementation, and utilization.

Information Flow - Communication of intelligence, facts, or data which are used as inputs to the decision process.

Uncertainty Faced - The extent to which there is a lack of conviction, absence of evidence, or lack of certain knowledge such that a decision can only be made on subjective probability estimates of outcomes of events.

Participation - Extent to which inclusion in the decision process is shared by organization members.

b. Decision Maker Characteristics

Goal Orientation - Extent of differences in decision making premises as a result of membership and identification with an organizational sub-unit.

Time Perspective - The length of the period considered by the decision maker in evaluating decision premises and outcomes.

Interpersonal Orientation - The manner in which organization members relate to each other; primarily in terms of task versus group and personal versus impersonal actions.

Sub-unit Membership - Belonging to a formally designated functional sub-division of the organization on to an informal group within the organization..

Openness - The degree to which decision makers are oriented to activities, events, and influences beyond those currently included in the objectives, policies, and programs of the organization.

C. Attributes of Innovation

Attribute - A characteristic or description of some quality or dimension of the innovation.

Technological Level - The extent to which an innovation is based on scientific knowledge or is designed, engineered, and produced according to scientific principles or based on concepts, techniques and methods derived from a scientific base.

Programmed/Unprogrammed - The extent to which the process of innovation can be routinized, i.e., a pre-set pattern established which can be replicated when similar conditions arise. Unprogrammed innovations are those which are unique and require specialized I/U procedures.

D. Innovation: Type

Type - This refers to the type of innovation based on the adopting unit. (The following classification scheme was devised by Rogers and Shoemaker, 1971, pp. 36-37).

Optional decisions "are made by an individual regardless of the decisions of other members of the system. Even in this case, the individual's decision is undoubtedly influenced by the norms of his social system and his need to conform to group pressures. The decision of an individual to begin to wear contact lenses instead of eyeglasses, and an Iowa farmer's decision to adopt hybrid corn are examples of optional decisions."

Collective decisions "are those which individuals in the social system agree to make by consensus. All must conform to the system's decision once it is made. An example is fluoridation of a city's drinking water. Once the community decision is made, the individual has little practical choice but to adopt fluoridated water."

Authority decisions "are those forced upon an individual by someone in a superordinate power position, such as a supervisor in a bureaucratic organization. The individual's attitude toward the innovation is not the prime factor in his adoption or rejection, he is simply told of and expected to comply with the innovation-decision which was made by an authority. Few research studies have yet been conducted on this type of innovation-decision, which must be very common [redacted] organizational society such as the U.S. today."

[redacted]ngent decisions "are a choice to adopt or reject which can be made only after a prior innovation-decision. An individual member of a social system is free to adopt or not to adopt a new idea only after his system's innovation decision. A teacher cannot adopt or reject the use of an overhead projector in his classroom until the school system has decided to purchase one; at that point the teacher can decide to use or reject the overhead projector."

Thus far our major objective has been to demonstrate how the contextual analytical method is applied to a specific problem (in this case I/U), and how the focus of analysis is successively narrowed to a point where meaningful, context specific and policy relevant analysis can be undertaken.

We have now reached the end of this stage of the paper. We have shown how the selection of a particular subset of interactive dimensions of structural attributes and contextual features is carried out, and we have elaborated on the details and specifics of this subset.

In the next section, we take this subset and demonstrate how the actual analysis that can be carried out once this stage is reached. As we have been maintaining all along, this analysis is primarily illustrative in nature - to give the reader an idea of how the contextual analysis can be applied to a particular area or situation. Thus, no claim to completeness is made. However, even when carried out for the purposes of illustration, the richness and detail that such an approach provides is quite evident.

VII ILLUSTRATIVE ANALYSIS OF SELECTED INTERACTIVE DIMENSIONS OF STRUCTURAL ATTRIBUTES AND CONTEXTUAL FEATURES

Analysis is possible in each intersection in the matrix in Figure 14. We shall follow the strategy of taking each of the structural attributes (columns) one at a time, and dealing with the various contextual issues that interact with it. Our treatment will, as always, be tempered by understanding of which are the more critical and robu[illegible] issues and factors whose examination and analysis will vide more valuable insights for both research and policy.

1. Formalization

Figure 13 shows the various issues that we will be discussing here in terms of their interaction with the structural attribute of formalization:

A. Pre-Implementation/Utilization Processes

Since formalization refers to the emphasis placed within the organization on following specific rules and procedures in performing one's job, this structural characteristic will usually act to facilitate the implementation and utilization. However, in pre-I/U activities, especially the knowledge-awareness stage, the assumption is that strict emphasis on rigid rules and procedures may prohibit organizational decision makers from seeking new sources of information. There is simply less opportunity for them to become more aware of potential innovations or to identify organizational performance gaps. Moreover, in those instances when performance gaps are identified, rules and

Formalization

1.	PRE I/U PROCESSES	
2.	INTRAORGANIZATIONAL ADMINISTRATIVE PROCESSES	
	a. Decision Making Characteristics b. Decision-Maker Characteristics	
3.	ATTRIBUTES OF INNOVATION	
4.	TYPES OF INNOVATION	

FORMALIZATION
INTERACTIVE
DIMENSIONS

Figure 13

COMPLEXITY

A.	PRE I/U PROCESSES	
B.	INTRAORGANIZATIONAL ADMINISTRATIVE PROCESSES	
	Decision-Making Characteristics	
	Decision-Maker Characteristics	
C.	ATTRIBUTES OF INNOVATIONS	
D.	TYPES OF INNOVATIONS	

COMPLEXITY
INTERACTIVE
DIMENSIONS

FIGURE 14

procedures specified by the organization may even prevent decision makers from taking corrective action. In short, the appropriate level of formalization is related to the stage of the innovation process. For example, Shepard (1967) has indicated that low formalization might be most appropriate at the initiation phase because it permits greater information flow, whereas a higher degree of formalization may be more appropriate during the implementation phase. During the initiation phase the organization needs to be open and receptive to new sources of information and alternative opportunities. The rules and procedures of a highly formalized organization may inhibit this openness.

In contrast, during implementation a singleness of purpose is required, and formalized policies and procedures act in this direction. For example, as noted in Neal and Radnor's (1973, p.22) study of successful implementation of operations research-management science activities in large scale organizations, "(there are) . . . significantly strong positive relationships between the establishment of an overall policy and procedural guides and the success of the OR/MS group." In addition, as Zaltman, Duncan, and Holbeck (1973, p.140) note,

> "they (Neal and Radnor) also found that other specific formalized procedures had been developed to facilitate implementation. These procedures covered such factors as formal project selection, long-range planning, scheduling, and regular progress reports. The formalization procedures appear to have reduced the problems of implementing OR/MS activities. Apparently, the formalized procedures they identified provide both information and specific technique that facilitate the organizational personnel's ability to utilize the innovation.

These differing requirements for formalization prior to and during I/U lead to a dilemma for the manager and the designers of organizations--so long as our general level of formalization is maintained throughout the organization. What is apparently required is a lower level of formalization during initiation and more formalized procedures for I/U activities.

To the extent that the same individuals or groups are involved in both the initiation and implementation/utilization phases, the need to alternate between operating styles poses an additional problem for organization members. That is, it becomes necessary to operate and manage in a more self-conscious manner than if one were to constantly use the same rules and procedures.

In any case, organizations will differ in the success they experience in I/U activities to the extent that an appropriate level of formalization can be attained in both I/U and pre-I/U activities.

b. Intraorganizational Administrative Processes

a. Decision Making Characteristics

Locus - In organizations, the decision to adopt an innovation may be made in a different sub-unit than the sub-unit in which the innovation is implemented and utilized. Therefore, it is essential to identify the locus of decision making which corresponds to the various stages of the innovation process. For example, the further the locus of the adoption decision is from the I/U unit in terms of a hierarchy of authority, in-

tervening functional sub-units, or geographically distant headquarters, the more compensating organizational mechanisms (such as liaison personnel or educational programs) must be introduced to insure acceptance in the implementation/utilization unit. In general, the more distant the unit making the adoption decision from the I/U unit the greater is the need for formalized procedures linking the two units.

Other effects of the locus of the adoption decision in relation to the I/U unit can be traced. A few of these are noted below in propositional form:

1) The greater the acceptance and/or perceived legitimacy of the adoption decision unit by the I/U unit, the greater the rate of adoption and the more effective the I/U process.

2) The fewer differences in perceptions and interpretations of organizational goals by the two units, the greater the rate of adoption, and the more effective the I/U process.

3) The greater the authority of the unit making the adoption decision relative to the I/U unit the greater the rate of implementation. (The likelihood of sustained implementation on this basis alone cannot be pre-determined).

Flexibility - Organizational strain is introduced by rigid adherence to formalized procedures for I/U activities in the face of the felt need for and the tendency to utilize more flexible decision making procedures relating to I/U processes. Such strains are likely to occur in organiza-

tions which originally developed along bureaucratic lines, with narrow and confining procedures governing the introduction of innovations, and which are now facing the need to introduce innovations at an increasing rate and level of complexity.

Basically the tension between formalized procedures and flexible decision rules in the I/U processes is resolved by modifying the organization to include an enlarged set of response modes to accomodate to new situations, each one of which can still be covered, at least to some extent by formalized procedures. To do this requires a higher order of organizational development and internal capability for organizational design. To the extent that organizations are able to do this it will be possible to satisfy the dual constraints of fomalized procedures and flexible decision rules.

Hierarchy - A clearly articulated hierarchical decision making structure tends to reinforce formalized I/U procedures; that is, both are distinguishing characteristics of bureaucratic organizations. In fact, these and the other characteristic features of the bureaucratic model, (i.e., a clean-cut division of labor, impersonal assignment of tasks and employment based on technical qualifications) are so successful in their fully-developed form that they tend to reduce the level and scope of innovation to those factors which are either easily introduced, as minor changes or additions to existing systems, or major changes forced on the organization through external authority or environmental change.

Transitional organizations, i.e., those undergoing an evolution from the bureaucratic to the adaptive organization, present an interesting set for contextual analysis. In these cases, the tendency is for both hierarchical

decision making and formalized decision rules to give way to more flexible and adaptive change patterns. The differential rate of change in these and other bureaucratic features will cause dysfunctional patterns to emerge. For example, if less hierarchical decision patterns are introduced without changing to formalized rules governing I/U activities, the rate of introducing change is likely to be accelerated, but the rate of unsuccessful implementation and/or utilization is also likely to increase as attempts are made to introduce innovations which do not fit the formalized rules governing these innovations. Also, the levels of frustration, role conflict and ambiguity among decision makers in the initiating and adopting unit are likely to increase.

Reconfiguration - This factor refers to the ability of organization members to re-form in different groups, depending on the decision or operational task in the innovation cycle. This factor is especially important when the same individual must participate in different groups performing innovation tasks or when the same group performs several innovation tasks. Formalized rules and procedures may interfere with the ability of organization members to re-configure, unless there are alternate procedures for different situations and sufficient flexibility in switching to these decision or operating modes.

Information Flow - Each stage of the innovation cycle has differing information requirements. The contrast is especially evident between the initiation stage (knowledge awareness, attitude formation, and the decision to adopt) and in the implementation and utilization stages. In the former, there is need for a free flow of information aimed at increasing current awareness, evoking interest, and

evaluating and deciding among alternatives. In the latter, the need for information is limited to the innovation selected and how to install service, maintain and utilize it. This second type of information is more readily collected and maintained according to formalized decision rules than the first, partly because the information is itself more routinizable in nature, and also because it is more easily organized according to its utilization. On the other hand, information during the initiation stage is more difficult to identify, to obtain and to assess. This is due in part to the uncertainty of the innovation process itself, i.e., by what criteria is the relevance, quality and quantity of the information collected determined? Secondly, who is responsible for obtaining this information, bringing it to the attention of decision makers and other organization members?

Such considerations become important in designing an information system for an organization. Apparently what is required is an information system modulated according to the stage of the innovation cycle under consideration. Formalized procedures for this system may serve both the initiation and I/U phase, but the orientation and scope of this formalization will vary considerably, if the innovation process is to be effective and efficient. To the extent that one information system with undifferentiated levels of formalization is adhered to the system will be both ineffective and inefficient.

Uncertainty - Innovation is accompanied by uncertainty throughout all its phases from need identification to sustained utilization. Formalized procedures are geared to

reducing uncertainty where possible, by providing organization members with clear cut decision rules and operating procedures. During I/U phases, formalized procedures have the intended effect of reducing uncertainty. However, formalized rules governing the flow of information in pre-I/U activities are dysfunctional, i.e., they tend to constrict the flow of information and limit it to certain types of information which the procedures are designed to process.

Participation - The larger the decision group the more difficult it is to maintain adherence to a formalized decision procedure. However, this extended participation tends to elicit a commitment to those innovations accepted by the decision group. Since formalized decision procedures tend to facilitate I/U activities, the problem becomes one of maintaining these formalized procedures while at the same time extending participation in the decision process.

Of course, the advantage of either of these organizational attributes may be gained in I/U activities at the loss of the other. In cases when adherence to formalized decision rules is stressed, the extent of participation in the decision process becomes a mediating contextual variable, and organizations will vary in both the extent of participation in decision making and the success of this participation for a given level of formalization of decision rules in the I/U process.

b. Decision Maker Characteristics

Goal orientation - Formalized I/U procedures tend to narrow the goal orientation to concerns of the adopting unit and

the I/U process. This may conflict with the goal orientation of other sub-units which are not so constrained. Equally important goal orientations within the I/U unit may vary widely from individual to individual with respect to innovation generally as well as to any given innovation. Thus, adherence to formalized I/U procedures may not change the basic goal orientation of sub-unit members with respect to innovation. To the extent that basic orientations are toward acceptance of the innovation, they reinforce adherence to I/U procedures. As such, they are an important but difficult to isolate contextual variable.

Time Perspective - During I/U activities, the time perspective usually shortens relative to pre-I/U user activities for a given innovation, since efforts are focussed on the immediate tasks of I/U. This is in contrast to the longer term implementions usually considered in the initiation phase, especially in making the decision to adopt an innovation. Additionally, formalized I/U procedures may vary from situation to situation depending on the time perspective required for the specific I/U activities at hand.

Interpersonal Orientations - Formalized I/U procedures foster and are reinforced by impersonal interpersonal relations, and by a task orientation versus group orientation. These dimensions of interpersonal relations are factors of great significance in organizations which are attempting to formalize I/U procedures. To the extent that impersonal relations and task oriented behavior are dominant organizational traits, it is hypothesized that it is possible to formalize I/U procedures.

Openness - The greater the openness to outside influences, the greater the likelihood of lessening strict adherence to formalized implementation and utilization procedures. The extent of interference is contingent on the degree of openness and the receptivity of members of the adopting unit to alternate innovation options.

C. Attributes of Innovations

a. Technological Level - This factor is a major determinant of the type of innovation process required for successful I/U. The larger the innovation relative to the existing system and the greater the amount of scientific and technological information required to complete implementation, the less applicable are formalized implementation procedures. The utility of formalized procedures is further reduced, the closer the innovation is to the frontiers of current scientific knowledge where uncertainty increases and related technologies are in rudimentary stages of development.

b. Level of Programming - The greater the extent to which the innovation process can be programmed, the greater the effectiveness of formalized procedures governing I/U processes. A high incidence of unprogrammed innovations in an organization reduces the need and incentive for formalized procedures.

c. Types of Innovations - The four categories of innovations noted in the preceding section (i.e., optional, collective, authority, and contingent) vary considerably in the applicability of formalized procedures during implementation and utilization.

Authority decisions handed down to organizational sub-units are probably most amenable to formalized procedures, followed

by contingent, collective and optional decision, respectively. This ordering is based on the decreasing role of the formal organization hierarchy in the adoption decision.

his concludes the interaction of one structural attribute, e.g., ormalization of I/U processes, with several contextual features. In aking this analysis an attempt was made to consider all contextual eatures to illustrate the utility of this approach. In considering ther contextual features, only a few salient interactions will be xamined:

. Complexity

igure 14 lists the various issues that topics that will be examined in his section in terms of their interactions with complexity as a structural attribute of the user organization.

A. I/U Processes

Complexity, as it has been defined in this study is really a multidimensional variable, i.e. the number of occupational specialties in the organization and their degree of professionalism with a very differentiated task structure. Just how these facets of complexity are integrated in the organization during pre I/U activities will have an impact on their functioning during I/U phases. In general: (1) the larger the number of occupational specialties in the organization, the higher their professionalism and the greater the differentiation of their task structures, and (2) the greater the complexity of the organization, the greater the number of proposed innovations but not necessarily the number of innovations adopted.

The higher rate of innovations proposed stems from the varied backgrounds and different tasks of organization members who have consequently different expectations of what the organization should be doing. On the other hand, as Burns and Stalker (1961) point out,

"because of differing expectations, there is likely to be more conflict about what should or should not be done." With a low rate of consensus it becomes difficult for the organization to implement and utilize new innovations; or as Wilson describes it (1966, pp.200-204), "high diversity (complexity) makes it difficult for any one source of authority to force some consensus toward agreement as to which of many proposals should be implemented." In short there is a basic conflict between the search for awareness of the innovation, and implementation. How organizations resolve this dilemma is of central importance in determining how complexity is used effectively in both initiation (pre I/U) and I/U stages of the innovation process.

Lacking any compensating arrangement, complex organization usually continues to experience a high level of innovations proposed and a considerably lower level of innovations adopted. If this were to occur without generating dysfunctional consequences, the main concern would be the lost number of potential innovations. However, negative side effects from this "natural selection" process include group and individual conflict, individual frustrations, and eventually, apathy and a lack of interest in trying to introduce new ideas. It should be noted that some might argue that this "survival of the fittest" approach results in the selection of the best ideas. While this viewpoint may in some sense be true, it ignores the above mentioned dysfunctional consequences; it also ignores the possibility that strong personal characteristics, political processes, and various forms of influence may result in a poor selection of innovations.

In any case, the dilemma of complexity remains, i.e., how to maintain a high level of idea-generation while managing the I/U processes so that the rate of adoption is not lowered as a result of a high level of conflict in the later stages of the innovation cycle. Sources of resolving this organizational dilemma becomes a key contextual variable, especially in highly complex organizations, as well as one experiencing a transition toward increased complexity.

B. Intraorganizational Administrative Processes

a. Decision Making Characteristics

The decision making process in an organization may interact in a variety of ways with organizational complexity, but in all cases the key point is the extent to which the decision making apparatus and process incorporate the various dimensions of the decision making process. We may pose the following question related to complexity.

1. Which specialties or professional groups are represented in the decision process? How do the relative weights of their influence determine the locus of decision making?

2. To what extent is varied professionalism and a large number of specialties reflected or not reflected in a more flexible decision process?

3. How does professionalism and varied task structure inhibit (or facilitate) re-configuration of the decision making apparatus in the pre I/U and I/U stages of innovation?

4. How is the increased flow of information, which is a requisite to higher levels of professionalism and differentiated task structure (i.e., complexity), incorporated in the decision process?

5. How does the level of complexity in an organization affect the uncertainty faced in the decision process?

6. How is the level of participation in the decision process changed as a result of increases in the level of professionalism and differentiation of task structure?

These and similar questions point to the intimate connection between complexity as a structural attribute in I/U and the decision processes governing these activities.

However, the rate, scope, and level of professionalism, as well as the complexity of task structures varies considerably from organization to organization. At the same time decision making gradually changes from a simplistic centralized, hierarchically organized process to a more participative, horizontally organized less formalistic process. The rate of this process of change has been so varied from organization to organization that few generalizations beyond overall tendencies are possible. Highly centralized autocratic authority patterns remain in organizations with high levels of professionalism, and other organizational attributes are required to explain differences in decision structures in what appear to be organizations at similar levels of complexity.

b. Decision Maker Characteristics

Higher levels of professionalism tend to result in changes in orientations. That is, goal orientations become more cosmopolitan, and professional and the time perspective becomes more long range. To the extent that these professionals participate in, or at least influence, the decision making process, these tendencies do not automatically facilitate I/U processes which require more attention to the immediate tasks of installing and utilizing innovations. However, it is dangerous to generalize since the installation of a particular innovation may be perceived by these same professionals as serving their personal long term goals, thus stimulating their desire to cooperate in I/U activities. The key point is that they are not always organizationally oriented and this is a prerequisite to the implementation process.

With respect to interpersonal relations and openness, professionalism engenders an impersonal outlook. At the same time the problem of risk taking, the need to exchange information and results, and the need to cooperate on structuring a problem and dividing it into manageable tasks all require an openness and trust which facilitates group interaction and consensus. To the extent that this is reflected in the decision process regarding new innovations it may facilitate their introduction and implementation. Thus, professionalism and varied task structure can strongly influence the extent to which the above mentioned attributes of openness and trust are reflected in the decision process with respect to innovation and as a consequence, influence the rate of adopting innovation as well as the effectiveness of I/U processes themselves.

C. Attributes of Innovations

Higher levels of organizational complexity are likely to correlate with higher technological levels of innovations being proposed by organization members. This would result primarily from the training and orientation of professionals who tend to operate on a level of sophistication commensurate with their education, experience and assigned tasks. Conversely, this same training may or may not result in effective I/U activities. While the level of expertise required to install and utilize a given innovation may be assured by the professionalism of the staff, it may be blocked by other professionals anxious to see their innovation adopted.

While this is a general tendency as indicated in the above discussion of pre I/U activities, more technologically advanced ideas are likely to increase group conflict over their adoption. First, since they are likely to be more expensive they use a higher percentage of scarce organizational resources for what is often perceived as a personal advantage for a colleague. Second,

the greater the advantage to a particular group of professionals or organizational subunit, the more difficult it is for them to see the direct benefits to the organization. Thirdly, the higher the technological level of an innovation the more likely there are to be difficulties in its implementation. Only those most committed to its adoption are likely to have the drive and perserverance to insure a successful implementation, but at the same time they need the cooperation of other sub-units.

D. Types of Innovations

It might be expected that collective and contingent decisions would be the most difficult to implement in organizations with high levels of complexity due to the need to get consensus on the adoption of an innovation. Conversely, optional decisions, to the extent allowed by the organization, might be more in evidence in complex organizations. This would follow from the high rate of innovations proposed in this type of organization, coupled with the advantage of the same unit being the decision and I/U unit. Aside from organizationally imposed limitations on the adoption of innovations there is the limitation imposed by the technology currently utilized by the organization itself. Some technologies form a more fruitful base for innovations than others.

3. Centralization/Decentralization

The interaction that will be examined here are listed in Figure 15.

A. Pre I/U Processes

The level of centralization operates in a manner similar to formalization and complexity. That is, a given level of centralization which may be appropriate for I/U activities may be ineffective in pre I/U activities. In a similar manner, the level of

CENTRALIZATION/DECENTRALIZATION

A.	PRE I/U PROCESSES	
B.	INTRAORGANIZATIONAL ADMINISTRATIVE PROCESSES	
	a. Decision Making Characteristics b. Decision-Maker Characteristics	
C.	TYPES OF INNOVATION	

CENTRALIZATION/ DECENTRALIZATION INTERACTIVE DIMENSIONS

FIGURE 15

centralization required for pre I/U activities relative to I/U activities, and the manner in which organizations develop differential levels of centralization for the two areas and/or set up compensating organizational mechanisms in the case of an undifferentiated level of centralization, become important contextual variables.

These assertions are derived from the following analysis. Highly centralized organization structures are dysfunctional in the pre-I/U phase since they inhibit the free flow of information, exchange of ideas, and the wide participation required to identify the various types of performance gaps and potential innovations to improve performance. A strict hierarchy, in contrast, requires adherance to pre-determined formal channels of communication, and a feedback of only positive information. In contrast, centralized authority having I/U phases is more appropriate and effective.

The organizational dilemma becomes one of maintaining the benefits of centralization in the implementation and utilization processes while finding ways to maintain the flexibility and openness required during pre-I/U activities. Organizations will differ greatly in their ability to develop an awareness of the needs of the two stages and to resolve them effectively.

B. Intraorganizational Administrative Processes

a. Decision Making Characteristics

The extent of participation in the decision making process and the degree of hierarchical arrangements in decision structures are key indicators of the amount of centralization (or decentralization) in decision structures. Also, the extent of this centralization in the decision process is reflected in organization structures which are strongly, but not uniquely, determined by attributes of the decision process.

In addition, increased participation in the decision process has a direct impact on the innovation process in both the initiation and implementation stages.

In general, it appears that more participation in decision making results in a higher rate of program change, i.e., adoption and utilization of innovations. This tendency is accompanied by a less centralized organization structure, or as Burns & Stalker's (1961) study revealed, the organic structure, with its smaller hierarchy of authority and wider involvement in decision making, is more effective in dealing with the more unstable conditions that often accompany attempts of innovation.

b. Decision Maker Characteristics

Hierarchical centralized decision making arrangements, coupled with strict adherence to procedures, tends to foster impersonal relationships. This tendency contrasts with the need of organization members to express their own viewpoints, especially when they differ with other members of the group. At the same time wider participation allows more personal expression and an opportunity to articulate differing, often minority opinions.

This open expression enforces the diversity of opinion noted above in discussing organizational complexity. As a consequence, it becomes more difficult for the organization to gather influence over participants with this diffusion of power and authority (Wilson, 1966).

From this perspective the problem of the organization design and the manager is more difficult than simply determining the level of centralization (or decentralization) required during

pre-I/U and I/U stages. It also becomes necessary to determine, in a given context, the impact of participation in the decision process on innovation. For example, wider participation increases the rate of initiation, and in many cases the rate of adoption of new ideas. But it also results in a loss in influence of the organization over participants.

As more ideas are proposed the potential for disagreement and conflict increases as well as the possibility for more openness and trust. A wider participation tends to reduce conflict by openning up channels for conflict resolution. Thus, it is difficult to determine, a priori, the impact of wider participation and interpersonal relationships; they simply cannot be determined without a fuller specification of other mediating contextual variables.

C. Types of Innovations

At least so far as overt acceptance of innovations is concerned, it is likely that those requiring adoption by the central decision making unit in an organization would be most easily implemented in highly centralized organizations. So long as innovation patterns are matched with this decision process and related organization structure, there are no apparent difficulties with the I/U process. That is, I/U can take place fairly successfully so long as innovations are sufficiently simple and do not require (a) unprogrammed implementation procedures, (b) a high rate of exchange of technical information and (c) a high level of trust, openness and commitment on the part of decision makers and organizational participants. However, these are precisely the conditions which are tending to occur in increasingly complex organizations and which, in turn, are encountering an increased rate and level of sophistication in the type of innovation proposed and adopted.

Integration/Differentiation

ese two structural attributes can usefully be considered together, ;ce they are complementary. The greater the degree of differenti- ion in an organization the greater the need to integrate the spe- ilized sub-units to achieve a common organizational purpose. The :ceding sections on formalization, complexity and centralization underscore the need for differentiation and specialization in pre- and I/U activities. This may take the form of differentiated uctures personnel, procedures and programs. For example, Zaltman al (1973, p. 138) offer a case which is illustrative:

> ". . .a highly diverse research-and-development unit might generate certain innovation proposals for changing the production process in an organization. These various proposals could then be presented to the less-diverse manufacturing division, which because of greater potential consensus in how they view their task, could more quickly and with less conflict select a proposal for implementation."

nany organizations it may not be possible to achieve such a large :ee of specialization, and other methods of differentiation must itilized. These methods become especially difficult to devise i the same personnel must perform the task of initiation and imple- :ation.

ll these situations, there is also a need to devise appropriate niques to link pre-I/U and I/U activities, but organizations differ heir ability to develop specialized sub-units and simultaneously to grate these units. In this regard, Lawrence and Lorsch (1967) have an empirical investigation of ten organizations in three industries etermine what organizational characteristics are required to deal different external markets and technological conditions. One of r most significant findings is that administrators in high perform- organizations have developed behavior patterns which enable them

effectively to manage differentiation (specialization) and integration in accordance with the demands of their particular environment. In essence, specialization and integration become strategic concepts in organizations for dealing with the impact of contextual variables.

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CHAPTER ELEVEN

AN OVERVIEW OF CONTEXTUAL POLICY ANALYSIS

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CHAPTER ELEVEN

AN OVERVIEW OF CONTEXTUAL POLICY ANALYSIS

The following are summaries of policy analyses provided by CISST for NIE and other agencies. They are intended to give the reader an understanding of the use of contextual analysis in the policy arena. For this purpose, we have "excerpted" pages 30-42 from the companion policy volume (Radnor and Hofler 1977).

1. Agency/Field Relationships in the Educational R/D&I System October 1976

As presented initially to us by NIE, the concerns of the Agency focused on two questions of procurement policy: (1) the appropriate balance between "field-initiated" vs. "NIE-directed" R&D; and (2) the appropriate mechanisms for procuring either field-initiated or NIE-directed work. Since these two questions are special cases of the broader and more critical issue of how NIE and the educational R/D&I field should relate, it was agreed that the policy analysis would focus on the agency/field issue.

In thinking about this issue, we were struck by the rather fundamental and broad-ranging implications of the questions raised, especially when viewed from the perspective of our understanding of R/D&I systems and processes and of the total, interactive processes in which R/D&I systems and processes exist and operate. Thus, there were some fundamental concerns which needed to be examined if the questions posed by NIE were to be responded to in an operational, policy and strategy relevant manner. These fundamental concerns included:

1. the nature of NIE's purposes and roles as a mission-oriented, lead agency in relation to educational R/D&I;

2. the impact of NIE's funding policies on NIE's purposes (as these impact on the total educational R/D&I sector);

3. the multiplicity of NIE purposes (including, in addition to substantive R/D&I outputs: building educational R/D&I system capacity; affecting the system's environment; providing system stability; system orchestration);

4. a large and diffuse operational system for education (i.e., the users of educational R&D products);

5. the relatively immature and loosely-linked nature of the educational R/D&I "system";

6. the differences in appropriate agency/field relations across the different R/D&I functions.

We were also concerned with considerations of program and project "portfolios" that would permit synergy and orchestration both within NIE and within the educational R/D&I system; with latent as well as the manifest purposes implications of specific programs, projects, policies and strategies; with non-procurement as well as procurement policies and strategies; with the nature and implications of a variety of strategies by which an agency can relate to various parts of the field.

In this analysis, we analyzed the agency/field issue separately for four key R/D&I functions: research (both basic and applied), development, dissemination and evaluation research. Each of these, in turn, was analyzed in terms of (1) the generic nature of the function; (2) the educational context; and (3) the implications for the role of NIE. A comparative analysis was then performed across these four R/D&I functions. This comparative analysis revealed several common themes (most specifically: a requirement

for NIE leadership; system building; and orchestration as the major NIE role) and some significant differences (most specifically in relation to time frames, the meaning of "excellence" for each function and key criteria for project selection). Finally, two brief scenario analyses were provided to illustrate how this policy analysis might affect policy and strategy decisions.

2. Assessment of Educational R/D&I

December 1976

Institutionalized Research, Development and Innovation (R/D&I) in education is little more than a decade old -- yet the R/D&I system capacity (as we can assess it now), our understanding of the system and our ability to manage it have increased significantly.

There is now a need to develop and refine, over the next few years, an analytical framework and a relatively unobtrusive monitoring system (for data gathering) with which the educational R/D&I system could be assessed in terms both of progress made to date and of what might reasonably be expected in the near term and longer term future. Such an assessment would provide the basis for annual or periodic reviews of the educational R/D&I system.

The analytical framework and the monitoring system for such assessment could be developed from a growing knowledge of R/D&I in other sectors and of the conditions pertinent to the education sector in particular.

In this brief overview report, we have suggested in broad terms what such a framework might look like; what should be the basis for assessment in the current and succeeding periods; what is the current status of key elements in the system and reasonable near and longer term expectations for (based on the incomplete

and tentative evidence and impressionistic judgements available at the time); and finally what major needs require consideration in formulating federal policy and program initiatives.

This report is based on some key premises:

1. that however weakly linked or integrated, the institutions and personnel involved in the production and utilization of educational R/D&I outputs do form a "system" and not just a group of disaggregated entities;

2. that R/D&I systems characteristically go through various stages of growth and development, with different needs and dynamics being present at different stages of development;

3. that over the past two decades, federal funding policies have reflected an increasingly broadening perspective of what constitutes an educational R/D&I system;

4. that these premises or perspectives have significant implications for long term planning and monitoring and for the development of initiatives by a federal agency.

This report has three parts: (1) an assessment of the development of educational R/D&I system capabilities over the past two decades; (2) an assessment (including a discussion of the basis for assessment) of the current status and needs of major R/D&I functions (specifically: basic research, problem-focused research, development, dissemination and evaluation research); and (3) a summary which suggests a general format for federal funding of educational R/D&I.

While we do throughout the report note weaknesses in the educational R/D&I system, we also emphasize that the current state of the educational R/D&I system must be assessed in terms of where it has been and where it now has the potential to go -- not in terms of unrealistic

expectations about "progress and output to date". Thus, it is important to note that what we have found would be generally about what one would expect to have found within a relatively young R/D&I system. There are weaknesses, but there has been progress and there are signs of the beginnings of a transition from the introductory stages of development.

3. Strengthening Fundamental Research Relevant to Education

August 1977

One part of NIE's overall responsibility is fundamental (basic) research relevant to education. In order to better fulfill this part of its responsibility, NIE sought the advice and counsel of the National Academy of Sciences (NAS). Their advice and counsel were presented in a report entitled: "Fundamental Research and the Process of Education" (1977). In response to the NAS report, the Program Committee of the National Council on Educational Research (NCER) presented a series of policy recommendations. Most notably, the NCER Program Committee recommended that 20% of NIE's total budget be allocated to fundamental research by 1979 and at least 30% by 1985.

While agreeing with the NAS conclusions that fundamental research relevant to education does need to be strengthened, there were a number of significant and potentially very dysfunctional deficiencies in the NAS report, and especially in the NCER Program Committee recommendations. For example, inadequate consideration was given to:

1) NIE's broad scope of responsibilities which cover many areas relevant to education -- e.g.: development, dissemination, as well as the improvement of education as a practice -- NIE cannot consider policies and strategies for fundamental research apart from its other responsibilities.

2) the impact that NIE policies and strategies regarding fundamental research could have on these other areas of NIE's responsibilities;

3) the policy and strategy implications of a number of critical aspects of the educational R/D&I context -- e.g.: the importance to education of experience-based knowledge vis-a-vis research-based knowledge; the nature of the educational fundamental research personnel and institutional bases (number; quality; interest and commitment to education; current capabilities to productively use what levels of increased funding; how fast they can be "built up"); the relative immaturity of educational R/D&I;

4) the role of NIE as a governmental, funding and "lead" agency in relation to the educational R/D&I context;

5) rationales or criteria to guide the policy and strategy deliberations of NCER and NIE.

Most specifically, the NCER Program Committee does not provide a rationale for recommending that 20-30% of NIE's total budget be allocated to fundamental research. Indeed, this recommendation appears to us to be highly dysfunctional when one considers that NIE has many other major responsibilities; that the costs for such R/D&I functions are significantly higher for applied research and for development than for fundamental research; that such a level of resource allocation could not help but restrict NIE's program planning flexibility.

Finally, the NAS report could be interpreted as providing a rational (1) that NIE is not needed as a funding agency; and/or (2) that there is no need to fund fundamental research whose focus is education per se.

This policy analysis, then, was developed to call attention to issues such as those above; to place consideration of fundamental research in a broader perspective of a total process of innovation, of NIE's more broadly scoped roles, and of the educational R/D&I context; and in so doing, to help provide a sounder basis both for the NAS committee's basic conclusion (that fundamental research relevant to education should be strengthened) and for policy/strategy decisions related to the conclusion. In this analysis, we do suggest a funding strategy as an alternative to the recommendations of the NCER Program Committee, as well as specific funding purposes and other non-funding strategies.

4. Regionalism in the Educational R/D&I Context
December 1977

As with the issue of agency/field relations, the issue of regionalism in the educational R/D&I context was selected by NIE. The importance of regionalism as an issue for NIE can only be understood in terms of the interactive impact on NIE of two aspects of the educational R/D&I: the "regional" educational R&D labs and the political environment of NIE.

First, in the mid 1960's, twenty educational R&D labs were established by the Office of Education (OE) under congressional legislation. By the mid 1970's, only eight of these labs remained, and their regional orientation had been lost to a very great extent. Currently NIE has responsibility for (and allocates a significant portion of its budget to) these remaining labs, even though they are autonomous organizations and are not technically a program of NIE.

Second, NIE's re-authorizing legislation specifies that a significant portion of NIE's budget be used to insure that the educational R&D needs of all regions of the country are met. The intent of the legislation appears to mean support for regional educational R&D labs, and the legislation has been so interpreted by the National Council on Educational Research (NCER Resolution 18).

At the outset of this analysis, we noted a lack of clear and common understanding about regionalism per se: nature and meaning of regionalism; the factors and dynamics which most critically impact regionalism; the contextual forces which push for or against regionalism or particular kinds of regional approaches; the nature and implications of alternative ways of conceptualizing and designing for regionalism. Thus, we chose to attempt to understand regionalism in ways that would be helpful to policy makers. In so doing, we found we were, in effect, breaking much new ground.

To develop such an understanding of regionalism we chose first to examine the context for regionalism. Thus, the analysis first overviews both the educational R/D&I context and the federal context (since NIE is a federal agency). As a next step, the analysis develops an understanding of conceptual and operational aspects of regionalism. The third step was to look at regionalism in relation to the various R/D&I functions. The final step, then, was to ask how these various aspects of the regionalism issue converge and interact in terms of designing for regionalism from the perspective of a mission-oriented agency such as NIE.

5. A Contextual Approach to Program Planning
September 1977

Unlike the rest of the materials in this collection, this piece does not provide a completed policy study. For the reasons to be later described in the preface to this paper the project could not be carried out as planned. However, the introductory section had been written prior to the aborting of the project and this contained some concepts which added an important dimension to our work. As such it was submitted to NIE as an interesting think-piece, and is therefore included in this spirit as part of the total collection of policy studies.

The paper focuses on the political context of the program planning process, but recognizing that NIE functions at the intersection of the political and scientific systems of which it is a part. As such, it elaborates on a point made in the Agency/Field Relations study in which we pointed out the need for NIE to take into account not only programmatic outputs, but also impact on the R/D&I system and its constituency, in its decision making.

The paper goes on to focus on the inadequacies of process and rational-systems frameworks for program planning and to make the case for the building in of political considerations in planning, namely such requirements as the need "to satisfice", to base policy making on incremental steps, etc. This then becomes integrated into system-wide considerations, which were to have included (but have not been developed in this paper) the implications for all the R/D&I system features (funding, personnel, research, development, dissemination, and so on). This leads to the recommendation that program planning should be conducted within a two dimensional framework, at the program level (in terms of values to NIE stakeholders: political system building) and at the project level (across the functional features of educational R/D&I: R/D&I system building). Finally, some considerations for the monitoring requirements to be generated are discussed.

6. R&D Coordination in the Social Science Context
November 1977

This analysis is a summarization (in modified form) of a paper presented at the Conference on Social Research Organizations at the University of Pittsburgh on October 20-22, 1977.

Coordination is a critical issue from a number of perspectives: Among the various R/D&I functions; between knowledge producers and knowledge users; among the various institutions and personnel and

across the various programs within a specific R/D&I function such as research; in terms of R/D&I system maturation and development; between funders and the "field"; and so on. Further, in the social science context, R&D coordination is especially problematic.

In this policy analysis, we view coordination from a broad rather than a narrow understanding of the concept of coordination -- a broad understanding which is not limited to issues of timing, resource allocation and integration in selection to specific programs, projects and related personnel activities. Rather, our understanding of coordination is one which focuses on the nature and needs of a total process of innovation, which considers the meaning of coordination in relation to a total process of innovation; to an R/D&I system of which specific organizations and their programs, etc., are a part; in relation to the larger context within which the R/D&I system and its organizations, programs and personnel exist and with which they interact; in relation to R/D&I system needs and purposes as well as the needs and purposes of organizations and their programs.

We have in this analysis attempted first to gain an understanding of the context of social science R&D can impact and be impacted by social science R&D coordination. Thus, we have in this analysis raised issues of R&D system maturation, emergent process of coordination, lead roles and agencies, and the nature of problems associated with the purposes social science R&D coordination might be intended to serve. These are, we believe, the type of issues which are critical for R&D coordination in the social science context.

7. Analysis, Selection and Planning of Programs and Projects by the Division of Industrial Energy Conservation of the Energy R&D Administration: Phase One Report
September 1977

The Industrial Energy Conservation Division (INDUS) of the Energy

Research and Development Administration (ERDA) has a mission which is broad in scope; requires consideration of many complex factors; must often be accomplished under conditions of high uncertainty or risk; and may involve conflicting governmental goals. Further, consideration must be given to the fact that INDUS must accomplish its mission as a "lead agency" among many autonomous institutions (industries) which have a large degree of ultimate control over the accomplishment of INDUS's mission. Further yet, since INDUS is a funding agency, there will be a "multitude of voices" besetting and beseeching the Agency for funding.

Thus, it is imperative that INDUS have a process for the analysis, selection and planning of programs and projects which:

1) permits analysis, selection and planning to be grounded in a comprehensive knowledge of the broad range of relevant system and environmental factors;

2) at the same time, permits identification of those factors which are most critical and/or about which current information is inadequate;

3) takes into consideration not only the knowledge production issues of R&D but also the "downstream" knowledge utilization issues and linkage issues of need identification, dissemination (including marketing, distribution, diffusion) and evaluation;

4) takes into consideration the nature and dynamics of the relationship between INDUS as a funding, lead agency and the "field" of knowledge producers and knowledge users;

5) takes into consideration both long and short term needs, dynamics and program/project implications;

6) permits orchestration and synergy across programs and projects.

This report, then, focuses on the development, in a manageable and useful format, of such an analysis, selection and planning process. The process suggested builds upon but extends current INDUS processes. It distinguishes between mission areas, programs and projects; thus projects are not considered in isolation but in terms of "portfolios" (i.e., programs). It provides both for organizational memory and for monitoring.

This report is a "phase one" report. It provides a basic outline of an analysis, selection and planning system in the form of flow charts and of specific questions to be raised at various stages of the selection and planning process. These are tentative and will require considerable interaction with INDUS personnel in order for the system design to be "tailored" to the specific context and needs of INDUS. This will be the focus of "phase two" of this project.

8. A Contextual Approach to Development and the Role of Technology in Developing Countries
September 1977

The subject of the role of technology in development of LDCs (Less Developed Countries) has received a great deal of attention in economic, science policy, R&D management and innovation literatures. To date, however, our knowledge is fragmented and often conflicting. Two of the prime bodies of the literature are focused on questions of:

(1) "Appropriate Technology" -- which is concerned with what kinds of technologies are appropriate to LDCs with their low capital and high unskilled labor availabilities as compared to the converse for the western nations, which are sources of most technology; with the implications that the technologies which have been exported from the advanced nations to the LDCs have not been appropriate; and

(2) "Dependency Theory" -- which criticizes the role of the western nations in third world countries (in terms of their having denuded LDCs of capital stock and of having replaced political colonialism with economic and technology based control).

These two perspectives find little integration in the existing literature. Nor do we find much to guide us in developing a comprehensive perspective as to the conditions that are determinate of appropriateness. Nor are we presented with any entry points to break into the dilemma between the desire to avoid dependency and the need to benefit from the sources of most technology that reside in the West -- usually within multi-national corporations (MNCs).

There was clearly a need to have a framework of analysis that could identify the rich complex of variables (political, economic, social, cultural and technological) that needed to be considered, and within which the tensions could be resolved. Besides being able to say what really did make a given technology more or less appropriate or what did/should determine the choice of techniques, we needed to be able to go further and identify "appropriate products," "appropriate R&D systems," etc. Clearly, the problems called for contextual analysis. In this work we are embedding the existing bodies of theory and current political issues (national and international) in our analytical scheme.

CHAPTER TWELVE

A LOOK BACKWARD AND FORWARD

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I. INTRODUCTION

In this short final chapter we wish to review what we have presented in this volume and point towards extensions and applications of our thinking.

In Chapters One and Two, we laid down our analytical framework, its rationale and the taxanomic content. Our purpose was to give the researcher and/or the policy analyst a comprehensive and systematic framework that contained many of the critical questions and issues that might need to be considered in relation to understanding and working with R/D&I systems. We have attempted to do this in a manner that would aid the user, whatever the issue to be dealt with or the conceptual perspective and/or the experience/theoretical base being used. We recognize however, that we could not be entirely successful in this latter regard. While our framework does permit a variety of approaches to be utilized it does lead the user towards our "view of the world" in terms of the issues and questions which are and are not raised. Nevertheless, we have laid down a compendium of topics and discussions about a variety of R/D&I questions that, at the very least, could prove stimulating to a potential user, and beyond that could provide a basis for research and policy analysis.

II. CONTRIBUTION TO RESEARCHERS

For researchers the framework has created a systematic basis for identifying critical variables related to any R/D&I issue and a structure for embedding such an issue in its broader phenomenological context. We do not present an elaborated theory about R/D&I systems. Rather, we provide a taxonomy of variables from which theories could be built. We did not provide the linkage between the variables (or questions as we have presented them). Of course, in that we have attached specific variables to the various functions and conditions, we have in fact presented hypotheses, or partial theories; but we chose not to go beyond

this level in presenting our framework. However, when we dealt with specific issues, either from a research or policy perspective, we introduced theoretical models to provide a basis for explanation and design. The reader must do the same, and this requires substantive knowledge in the areas being considered.

Even with these caveats, we believe that what we have presented can be of substantial assistance to the researcher in organizing and structuring research questions on R/D&I processes, identifying critical variables, identifying gaps in the literature, organizing knowledge, etc. In Chapters Eight, Nine and Ten, we presented analyses of topic areas that might act as examples and stimulants to researchers in using our framework. These were on institutional relations, on entrepreneurship and on implementation/utilization.

There is another dimension that we see benefiting the researcher, that of comparative research across sectors. Researchers sometimes wish to do this but generally lack the necessary contextual information that could inform them of salient conditions that varied (or were common) across sectors that should be considered in theories and research designs. Chapters Three through Seven (which described the R/D&I systems in education*, aviation, health and law enforcement) could make a contribution here. For research across those particular sectors, and beyond these to other sectors, these chapters provide an example of type of empirical data needed and feasible to obtain with a reasonable expenditure of resources. It should be noted that in none of the four sector cases presented were we able to undertake any large scale primary empirical research on the R/D&I system concerned. We had to depend on secondary sources, reinforced by our own general backgrounds. We see the descriptions

*For those readers with a special interest in education it should be borne in mind that Chapter Three is an abbreviated form of a complete volume that we have prepared on the educational R/D&I system (Spivak and Radnor 1977

presented as but a first step for continued in-depth studies -- but also as a demonstration of the utility of our framework for collecting and organizing existing data into a useful and relatively comprehensive description to an R/D&I sector. Finally, the same arguments would apply for researchers beginning to do R/D&I research in a sector with which they are not familiar. The actual (or type of) presentations developed for Chapters Three through Six could be an important starting point for developing needed background data.

In summary then, for the research communities we see our work (as presented in this volume) as providing a possible basis upon which to build research agendas (what is needed to fill gaps - especially in our empirical data bases), to contribute to theory building, to improve research designs (by increasing awareness of competing sources of variance and of plausible alternative hypotheses, of opportunities for natural experiments through increased awareness of the contextual processes), and to facilitating comparative and multi-sectoral research. Finally, we might hope that by sensitizing the researcher to a wider range of critical issues that may be of significance we might also contribute to an expansion of linkages across disciplenary boundaries, and between researchers and practitioners.

III. CONTRIBUTION TO POLICY ANALYSTS

In this volume we have only briefly indicated the potential contributions of our framework policy analysis. For a more complete exposition and presentation of case examples, the reader is referred to the companion policy-oriented volume (Radnor and Hofler 1977) as well as to the volume we have developed on issues of information dissemination and exchange in educational R/D&I (Radnor, Hofler and Rich 1977).

For now, we limited ourselves in this volume to signalling the applications of our framework to policy through the brief overview in Chapter Eleven and by some of the discussions in Chapters Eight, Nine and Ten (see for example the policy implications discussed with respect to producer/entrepeneur-user relations in Chapter Nine).

IV. NEXT STEPS

For the present reader, one of the important and natural next steps has already been taken, namely the application of our framework to R/D&I policy issues. These are contained in the above cited policy volumes.

With respect to the materials presented in this volume the need to deepen and expand the discussions is clear. One important dimension of this effort will be to undertake empirical work to support, modify and add insight where this is needed. Another, perhaps more important, aspect of this point is to expand the conceptual base of the discussion.

The danger is that we could become trapped by our view of the world, useful as it might prove to be. It is vital that we create the opportunity for other conceptual perspectives to become elaborated with respect to R/D&I issues and policy questions -- in their own terms. We can then go on to see what, if any, intersections exist; where differences emerge and whether and where syntheses can take place; where the separate conceptions can provide alternative and separately useful sources of explanation and bases for policy decisions. This work has already been initiated.

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